

Postoperative upper airway problems

Lisa Zuccherelli, MBBCh (Wits), DA (SA), FCA (SA)

Private Practice, Johannesburg

Introduction

General anaesthesia has undergone many refinements and advances in the last few decades. The introduction of safe, short-acting induction and maintenance agents with few side-effects, and airway devices such as the laryngeal mask airway, have revolutionized anaesthesia to the point where major complications and morbidity are rare occurrences. Unfortunately, the incidence of some minor complications has not been influenced at all by the wealth of technology at our disposal. In particular, a complaint of postoperative pharyngeal discomfort is so prevalent that it is almost expected by patients and anaesthetists alike as an unavoidable part of routine anaesthesia. Complaints range from a minor throat irritation to debilitating pain, inability to swallow and temporary voice changes, and are a frequent observation on the postoperative visit. Whilst seldom delaying discharge, these complaints nevertheless affect patient satisfaction and may well affect their activities after leaving hospital. In a small number of cases, pharyngo-laryngeal injury may take months to recover and may even be permanent. For this reason, follow-up of minor complaints should be considered an essential component of the postoperative visit, as timely referral and intervention may prevent irreversible damage.

TERMINOLOGY

A post-operative complaint of "sore throat" is often a generic term for a number of symptoms⁽¹⁾, and more detailed questioning usually reveals one or more of the following:

- Pharyngeal dryness – very common, dryness or feeling of thirst
- Sore throat – continuous throat pain, may be mild, moderate or severe
- Dysphagia – unco-ordinated swallowing or inability to swallow or eat
- Odynophagia – pain on swallowing or eating
- Dysphonia – hoarseness or voice changes

INCIDENCE

There is no doubt that the highest incidence of sore throat and other airway-related symptoms tends to occur in patients who have undergone tracheal intubation with an endotracheal tube (ETT), even after ambulatory surgery of short duration (< 1 hour), although it is almost ubiquitous after prolonged intubation (> 12 hours). With the introduction of the laryngeal mask airway (LMA) into clinical practice, it was anticipated that the incidence would fall dramatically – unfortunately, this has not been the case. Indeed, there is a small but definite incidence of postoperative sore throat with the humble face mask (FM), even without insertion of a Guedel air-

way. A number of factors, some avoidable, influence the incidence and extent of postoperative pharyngeal symptoms, but it is unlikely that this problem will ever be completely abolished.

A review of the literature indicates the following incidences:-

a. Sore throat

ETT: 14 – 50% (up to 90% in some studies)

LMA: 6 – 34% (up to 44%)

FM: 3 – 8%

b. Hoarseness

ETT: 4 – 42% (mean duration 3.5 days)

LMA: 9 – 21%

c. Permanent dysphonia

ETT: 0.4 – 3% (at 6 months follow up)

d. Pharyngeal dryness

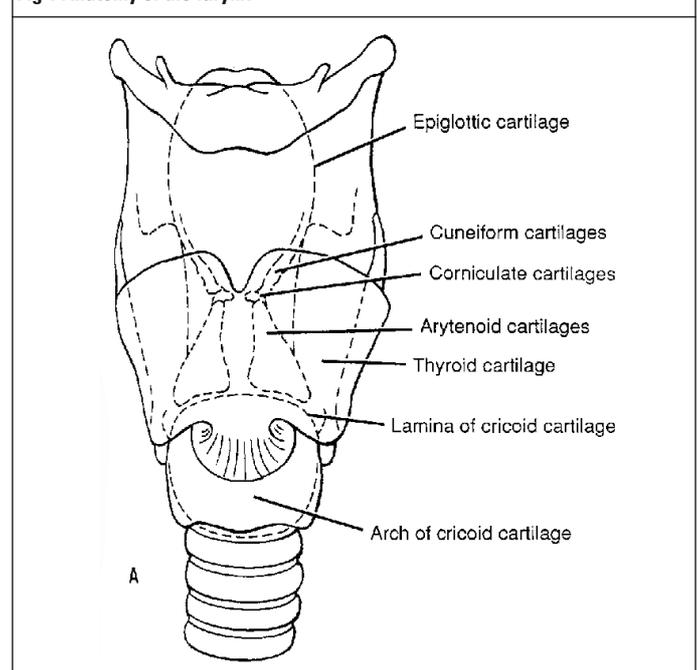
ETT: 75%

LMA: 61%

PATHOLOGICAL CHANGES

The site of most applied force is different when comparing insertion of an ETT to a LMA⁽²⁾. With the LMA, the main force is exerted at the end of the soft palate and the pharyngeal wall directly behind, whereas with the ETT, it is the hard palate and the entrance to the trachea and larynx. This explains why dysphonia is more likely to occur with the ETT, whereas dysphagia is more common with the LMA. Nevertheless, the 2 devices share many injuries in common (figure 1)

Fig 1 Anatomy of the larynx



Correspondence:

Dr L Zuccherelli

email: costas@iafrica.com

After intubation

- oedema over the posterior cricoid plate and tracheal rings anteriorly
- oedema/haematoma/erythema of the vocal cords and vocal processes of the arytenoids
- annular mucosal epithelial loss and polymorphonuclear infiltration from the cuff of the ETT (can be seen after intubation < 1 hr)
- “crushed” epiglottitis
- submucosal tears – commonly pyriform fossa laceration
- contact ulcer of the vocal cords – may progress to granuloma
- pharyngeal/oesophageal perforation – associated with use of rigid stylet
- fracture of cricoid cartilage – from vigorous application of cricoid pressure
- nerve palsies – recurrent laryngeal and external branch of superior laryngeal nerve

After LMA

- pharyngeal erythema – most common finding
- arytenoid dislocation – from folding back of the LMA tip
- epiglottitis – also from folding back of the LMA tip
- uvular bruising
- nerve palsies – recurrent laryngeal, hypoglossal and lingual

Recurrent laryngeal nerve palsy

The recurrent laryngeal nerve (RLN) is a branch of vagus, and ascends to the larynx on either side in the tracheo-oesophageal groove. At the apex of the pyriform fossa, it enters the larynx behind the crico-arytenoid joint (CAJ), and divides into a motor and sensory branch. The motor branch innervates all the intrinsic muscles of the larynx, except the cricothyroid, but including the vocal cords. Compression of the nerve may occur between the ETT cuff and the arytenoid and cricoid cartilages, or from LMA cuff pressure at the point where it lies unprotected in the pyriform fossa.

Hansch et al⁽³⁾ looked at the incidence of laryngeal nerve paralysis after intubation. All patients underwent direct laryngoscopy prior to intubation and previously unknown unilateral laryngeal nerve palsies were diagnosed in 1.9% of cases. Postoperatively, a further 1.4% of patients had unilateral nerve palsies. This was permanent (> 6 months) in 0.5%.

AETIOLOGY OF SORE THROAT AFTER INTUBATION
Size of ETT

Larger ETT's tend to be associated with a higher incidence of postoperative sore throats. In a study comparing large tubes (size 9.0 mm for men, 8.5 mm for women) to small tubes (7.0 mm for men, 6.5 mm for women), the incidence was 48% for large tubes and 22% for small tubes⁽²⁾. No ventilatory difficulties were experienced as a result of using smaller tubes in ASA 1 or 2 patients.

Gender difference

Some studies have shown that females have a higher incidence of sore throat than male patients, and this has been attributed to the tube often being a tighter fit⁽⁴⁾. Generally, however, there does not appear to be a sex difference in most studies to date.

ETT cuff pressure

A high pressure, low volume cuff, such as the red-rubber ETT, has been implicated as a cause of serious complications, especially after long-term intubation. Mucosal arteriolar perfusion pressure has been measured at 32 mmHg, and an intracuff pressure of > 30 mmHg consistently abolishes mucosal blood flow, resulting in ischaemia and subsequently tracheal stenosis or tracheomalacia. The newer thin-walled, low pressure, high volume cuffs do not affect mucosal blood flow until intracuff pressures are 80 – 120 mmHg, due to more even distribution of pressure over the mucosa. Nevertheless, the recommendation is that intracuff pressures should always be maintained at < 20 mmHg to prevent mucosal ischaemia. High pressures may be responsible for causing pressure-induced neuropraxia of the recurrent laryngeal nerve, as the nerve can be compressed between the cuff and the cricoid and arytenoid cartilages. Frequent intra-operative monitoring and adjustment of intracuff pressure is essential to avoid this complication.

ETT cuff design

Low pressure, high volume cuff design has also been implicated as a cause of postoperative sore throat, because the high volume cuff comes into contact with a large area of tracheal mucosa. However, compared with the high pressure cuff, the damage is more superficial. Another problem with the high volume cuff is that if the diameter is greater than that of the trachea, the redundant material wrinkles, causing deep mucosal grooves. In addition, aspiration is not prevented. The ideal cuff, therefore, should have a diameter slightly less than that of the trachea and should allow a 10% increase in diameter over the range of inflating pressures to avoid wrinkling. Furthermore, the cuff should be narrow to minimize the cuff-tracheal contact area. Although the Mallinckrodt ETT fulfils all of these criteria, it is still possible to inflate the cuff beyond the recommended 20 mmHg. The Brandt Anaesthesia Tube is designed to prevent intracuff pressure from increasing above 25 mmHg, by virtue of the cuff communicating through the inflation line with a pilot balloon that is more compliant and of higher volume. The incidence of sore throat with the Brandt ETT was 15% compared to 60% for the standard Mallinckrodt ETT in one study⁽⁵⁾.

Nitrous oxide

The routine use of nitrous oxide is being challenged for a number of reasons, least of all for its cost. Intra-operative diffusion into air-filled spaces has been shown to increase the volume of the ETT cuff by 9 – 38% within the first 30 minutes of anaesthesia.⁶ Similar changes in pressure may be recorded, depending on the volume and pressure on initial inflation. If nitrous oxide is used intra-operatively, it is recommended that the cuff be inflated with saline or with gas drawn directly from the breathing circuit, rather than air.¹ In addition, the cuff seal point should be determined after tracheal intubation and intermittent measurement and adjustment of intracuff pressure should be routine clinical practice.

Insertion technique and trauma

A number of factors at insertion and removal of the ETT will affect the incidence of sore throat. A slick, uncomplicated intubation in a patient with normal anatomy will result in fewer pharyngeal complications⁽⁷⁾. Not surprisingly, the proficiency

of the anaesthetist is one of the most important factors affecting the incidence of sore throats and hoarseness⁽⁸⁾. A patient with abnormal anatomy may present a problem at intubation, with multiple attempts and more likelihood of trauma to the pharyngeal structures. The use of an intubating stylet has been correlated with postoperative sore throat, probably indicating a more difficult intubation. The McCoy laryngoscope has been implicated in causing complete disruption of the cricoarytenoid joint, although it is a useful tool for difficult intubation⁽⁹⁾. Failing to deflate the cuff adequately before intubation or extubation may result in the bulk of the cuff causing damage, whilst the presence of blood in the airway or on the ETT at extubation is also a predictor of sore throat. An important observation is that more patients with pharyngeal injuries are likely to complain of sore throat or hoarseness than those without injuries on postoperative direct laryngoscopy.

Topical lignocaine

The topical application of lignocaine to either the ETT or the pharyngeal structures has been repeatedly shown to cause postoperative sore throat. It is postulated that the lignocaine remains on the mucosa and acts as an irritant, because water-soluble lubricating gels do not have this effect⁽¹⁾. In addition, local anaesthetic spray or gel may "anaesthetize" the vocal cords and result in temporary postoperative hoarseness. Lubrication with 1% hydrocortisone cream may also result in a higher incidence of sore throats compared with controls, but spraying the upper airway with a single dose of beclomethasone (50µg) from an inhaler, reduces the incidence to 10%, compared with 55% for lignocaine spray⁽¹⁰⁾.

Inadequate relaxation

With the recent tendency amongst anaesthetists to avoid unnecessary muscle relaxation, it is to be anticipated that the incidence of pharyngeal complaints will increase. Excessive laryngeal motor activity, such as occurs when patients cough or strain against the ETT or during light anaesthesia, can cause vocal cord haematoma and granuloma. This is a particular problem in unsedated patients who are ventilated in intensive care. The increasingly common technique of intubating patients without a muscle relaxant has been shown to result in a high incidence of postoperative sore throat (\pm 40% of cases) and voice changes, which typically last much longer than pharyngeal complaints after intubation with a muscle relaxant⁽¹¹⁾. The left vocal cord is more frequently injured because the laryngoscope is usually held in the left hand with the endotracheal tube being inserted from the right side and turned to the left⁽¹²⁾. In addition, when using a small ETT in an unparalyzed patient, excessive motion of the tube against the vocal cords during the procedure may lead to laryngeal ulceration and subsequent scarring.

Urgency of intubation

Urgency of intubation is another factor responsible for sore throat, and is related to failure to wait for the onset of adequate muscle relaxation, or pharyngeal trauma when hastily trying to intubate a rapidly desaturating patient. The velocity of intubation appears to have an effect on damage to the cricoarytenoid joint (CAJ) capsule; rapid intubation leads to synovial fold damage more often than gradual intubation⁽¹³⁾. This damage causes a serosynovitis or haemarthrosis within the

joint, with subsequent fixation of the arytenoid in an abnormal position. Some patients are predisposed to CAJ damage as a result of congenital laxity of the capsule with large synovial folds, but are typically asymptomatic. Care should be taken to avoid damage caused by hasty intubation in all patients.

Nasogastric tube

There are a number of reports of postoperative recurrent laryngeal nerve palsy as a result of nasogastric tube pressure on the nerve where it lies between the laryngeal mucosa and oesophagus. Both uni- and bilateral injuries have been reported, usually after prolonged intubation and ventilation. However, there are reports of paralysis after routine surgery and extubation⁽¹⁴⁾. The hard Reye's tube is more commonly associated with this problem and should be avoided as far as possible

Aspiration or bleeding

Gastric secretions or bleeding may cause sore throat and hoarseness postoperatively as a result of inflammation or chemical response to these irritants. Indeed, singers are frequently advised by voice experts to take prophylactic antacids and anti-reflux medication perioperatively, even before elective surgery⁽¹⁵⁾.

Patient positioning

Both lithotomy and prone positions have been associated with a higher incidence of sore throat, possibly because the ETT tends to ride up in the pharynx, allowing the cuff and tube to rub against the vocal cords and mucosa. In addition, these positions cause mucosal venous congestion and a concomitant increase in pharyngeal wall pressure.

Obesity

Obese patients are more likely to be difficult to intubate and ventilate, and larger tubes are often chosen in an attempt to decrease airway resistance. These factors both increase the likelihood of postoperative sore throat.

Suctioning

Vigorous, deep suctioning before extubation may damage pharyngeal tissues as a high negative pressure is exerted on the mucosa. Indeed, fewer sore throats are reported after anticholinergic premedication, possibly because less suctioning is required at the end of the procedure. Care should be taken to suction as superficially and briefly as possible, and to use a soft catheter with a broad tip.

AETIOLOGY OF SORE THROAT AFTER LMA

Insertion technique

As the insertion of a LMA is predominantly a "blind" procedure, injuries are often unsuspected. Although there are 17 different methods of insertion described in the literature, commonly, the LMA is inserted fully deflated, semi-inflated or fully inflated, with or without an insertion aid. Many studies have shown that inserting the LMA fully inflated using an insertion aid gives the lowest incidence of postoperative throat complaints, the reason being that a softer leading edge is presented to the posterior pharyngeal wall. However, inserting the LMA inflated is more likely to result in the epiglottis fold-

ing over, which has also been associated with sore throat. Brimacombe ⁽¹⁶⁾, using the standard, fully deflated technique of insertion reported a 30% incidence, whereas Wakeling compared standard vs. inflated insertion and found that the incidence was 21% deflated compared to 4% inflated ⁽¹⁷⁾.

Multiple attempts at insertion are associated with poor technique, epiglottic down-folding and uvular bruising, whereas the use of an insertion device may reduce the number of failed attempts at insertion, and hence result in fewer sore throats ⁽¹⁸⁾. The introducer also prevents the tip from folding back and allows the leading edge to pass more easily around the curve of the pharynx ⁽¹⁹⁾.

Intracuff pressure

Presence of a LMA distorts normal pharyngeal architecture, resulting in an increased antero-posterior diameter at the level of the tongue and epiglottis, as well as tilting the larynx anteriorly. This can cause direct pressure on, and stretching of the recurrent laryngeal nerve. Vocal cord paralysis ensues, usually unilateral and temporary in nature, but occasionally bilateral and life-threatening ⁽²⁰⁾. In addition to recurrent laryngeal nerve palsies, overinflation of the cuff may be responsible for hypoglossal and lingual nerve palsies reported in the literature.

There is conflicting evidence as to whether limitation of pressure exerted on the pharyngeal mucosa by the LMA cuff reduces throat symptoms in spontaneously breathing patients. However, in patients ventilated through the LMA, minimizing cuff pressure has been shown to cause significantly fewer sore throats postoperatively ⁽²¹⁾. There is evidence that airway sealing pressure is usually optimal at submaximal cuff volumes and pressures, which suggests that it is the matching contours of the cuff and pharynx, rather than the transmitted pharyngeal mucosal pressure, which provide the airtight seal. Volumes need only be enough to achieve a gas-tight seal, and this may be acceptable with as little as 4 – 11 ml air in women and 7 – 14 ml in men ⁽²²⁾.

O'Kelly showed that when the LMA cuff is inflated with the suggested appropriate volume of gas, a pressure similar to, or greater than, the mucosal perfusion pressure of 32 mmHg may be generated ⁽²³⁾. With a size 3 LMA, 10 ml of air causes an intracuff pressure of 19 mmHg, whereas 20 ml of air causes a pressure of 49 mmHg. Similarly, 10 ml air in a size 4 LMA causes 14 mmHg pressure, whereas 30 ml air causes 54 mmHg pressure. Intra-operative use of nitrous oxide may increase the intracuff pressure in a fully inflated LMA to well over 100 mmHg. Unless IPPV is anticipated, there is no need for a tight seal when using the LMA, so submaximal inflation volumes should be used.

It has also been observed that high cuff pressures may lead to more sore throats in female patients than in males. The anatomical form of the female larynx is rounded, whilst that of the male is lengthened in an antero-posterior direction. Overinflation may have the effect of distending the hypopharynx, particularly in women, leading to soreness ⁽²⁴⁾.

The ProSeal LMA (PLMA) has new features compared with the classic LMA. The additional tube draining the oesophagus and the large wedge-shaped cuff could theoretically overcome the problems of the LMA in obese patients, since the airway seal pressure is greater and regurgitated fluid can be drained directly or by means of a nasogastric tube. Although the air-

way seal pressure needed to obtain a minimal leak is greater in obese patients, it appears that sore throat is not always related to cuff inflation pressure. A study comparing mechanical ventilation of moderately obese patients through either the LMA or PLMA, found the incidence of postoperative sore throats to be about 13% in both ⁽²⁵⁾, and both were equally effective for positive pressure ventilation. Evans found the incidence of postoperative sore throat with the PLMA to be 23%, which is similar to the classic LMA, in spite of the fact that mean airway sealing pressures were 10 – 12 cm H₂O higher than those described for the classic LMA.

Further studies will elucidate the role of cuff volumes and pressure and their effect on postoperative sore throat. Until such time, it is prudent to avoid overinflation and to monitor and adjust cuff pressure whenever possible.

Size of LMA

Very few studies have looked at the incidence of sore throat with different sizes of LMA's. The manufacturers currently recommend using the largest size possible in order to achieve a good seal at the lowest possible pressures. Grady compared the incidence of pharyngolaryngeal morbidity after the use of a large (size 5 in males, size 4 in females) or small (size 4 in males, size 3 in females) LMA in spontaneously breathing patients ⁽²⁶⁾. He found that selection of a small LMA in males and females decreases the incidence of postoperative sore throat and hoarseness.

Nitrous oxide

As with the ETT, diffusion of nitrous oxide into the LMA cuff is associated with an increase in cuff pressure by 20% after 30 minutes ⁽²¹⁾, and consequently, a higher incidence of sore throat. In addition to nitrous oxide diffusion, the volume of gas in the cuff increases when air inside it is raised from room to body temperature.

Lignocaine

Lignocaine gel or spray causes a higher incidence of hoarseness and tongue paraesthesiae, but not of sore throat. A case of bilateral vocal cord palsy secondary to lignocaine jelly diffusion around the recurrent laryngeal nerve has been described. The local anaesthetic may remain in contact with the mucosa for a considerable length of time - diffusion is also more likely when gel has been generously applied. Water soluble gels or saline are effective alternatives.

Anticholinergic premedication

In contrast to the reduced incidence of complaints seen with ETT's, anticholinergic premedication has been associated with an increased incidence, probably due to the drying out effect on pharyngeal mucosa, making insertion of the LMA more difficult.

Duration of surgery

An especially important factor when nitrous oxide is being used, as for ETT's. Even when cuff pressure is measured and adjusted regularly, longer procedures are still associated with more postoperative complaints. Foley et al showed that the incidence increases significantly after surgery of more than 60 minutes duration, and tends to be worse when active heated humidification is used ⁽²⁷⁾.

MANAGEMENT OF THE PATIENT WITH HOARSENESS OR SORE THROAT

- Reassure the patient – most symptoms will resolve spontaneously.
- Prescribe a gargle containing a topical non-steroidal anti-inflammatory (NSAID) and a local anaesthetic (eg Andolex C ®). Gargles are alkaline solutions which become concentrated in inflamed tissue and are minimally systemically absorbed. In addition, a systemic NSAID may be prescribed to decrease synovitis in the CAJ capsule.
- Encourage the patient to rest his or her voice – this prevents a contact ulcer or haematoma from developing into a chronic granuloma with scarring.
- Consider referring the patient with both hoarseness andodynophagia, as an injury is more likely in this setting.
- Any patient who remains hoarse for more than 5 days should be referred to an ENT surgeon for evaluation.

Avoiding postoperative sore throats - summary		
General principles	After tracheal intubation	After LMA insertion
Experience of anaesthetist	Smaller tracheal tube	Correct size of LMA
Adequate anaesthesia/relaxation of patient	Minimal cuff tracheal contact area	?Inflation of cuff before insertion/ use of insertion aid
Careful technique	Monitoring and adjustment of intracuff pressure	Use of KY jelly/saline lubricant
Soft suction catheters	Avoidance of local anaesthetic/steroid lubricants	Minimisation of intracuff pressure

References

1. McHardy FE, Chung F. Postoperative sore throat: cause, prevention and treatment. *Anaesthesia* 1999;54(5):444-53.
2. Chandler M. Tracheal intubation and sore throat: a mechanical explanation. *Anaesthesia* 2002;57:155-61.
3. Hansch FT, Eichfeld U, Steinert M, et al. Recurrent laryngeal nerve paralysis as intubation injury? *Chirurg* 200;71(5):539-44.
4. Stout DM, Bishop MJ, Dwersteg JF, et al. Correlation of endotracheal tube size with sore throat and hoarseness following general anaesthesia. *Anesthesiology* 1987;54:419-21.
5. Jensen PJ, Hommelgaard P, Sondergaard P, et al. Sore throat after operation: influence of tracheal intubation, intracuff pressure and type of cuff. *BJA* 1982;54:453-7.
6. Stanley TH. Nitrous oxide and pressure and volumes of high and low pressure endotracheal tube cuffs in intubated patients. *Anesthesiology* 1975;54:637-40.
7. Christensen AM, Willemoes-Larsen H, Lunby L, et al. Postoperative throat complaints after tracheal intubation. *BJA* 1994;54:786-7.

8. Jones MW, Catling S, Evans E, et al. Hoarseness after tracheal intubation. *Anaesthesia* 1992;47:213-16.
9. Usui T, Saito S, Goto F. Arytenoid dislocation while using a McCoy laryngoscope. *Anesth Analg* 2001;92(5):1347-8.
10. el Hakim. Beclomethasone prevents postoperative sore throat. *Acta Anaesthesiol Scand* 1998;37:250-2.
11. Mencke T, Echternach M, Kleinschmidt S, et al. Laryngeal morbidity and quality of tracheal intubation. *Anesthesiology* 2003;98(5):1049-55.
12. Peppard SB, Dickens JH. Laryngeal injury following short-term intubation. *Ann Otol Rhinol Laryngol* 1983;92:327-30.
13. Paulsen FP, Jungmann K, Tillmann BH. The cricoarytenoid joint capsule and its relevance to endotracheal intubation. *Anesth Analg* 2000;90:180-5.
14. Ibuki T, Ando N, Tanaka Y. Vocal cord paralysis associated with difficult gastric tube insertion. *Can J Anaesth* 1994;42(5 Pt 1):431-4.
15. Powner DJ. Airway considerations for professional singers – a survey of expert opinion. *J Voice* 2002;16(4):488-94.
16. Brimacombe J, Berry A. Insertion of the laryngeal mask airway: a prospective study of four techniques. *Anaesth Intensive Care* 1993;21:89-92.
17. Wakeling H, Baxter P. The laryngeal mask airway: a comparison between two insertion techniques. *Anesth Analg* 1997;85(3):687-90.
18. Dingley J, Whitehead MJ, Wareham K. A comparative study of the incidence of sore throat with the laryngeal mask airway. *Anaesthesia* 1994;49:251-4.
19. Evans NR, Gardner SV, James MF, et al. The proseal laryngeal mask: results of a descriptive trial with experience of 300 cases. *Br J Anaesth* 2002;88(4):534-9.
20. Sacks MD, Marsh D. Bilateral recurrent laryngeal nerve neuropraxia following laryngeal mask insertion: a rare cause of upper airway morbidity. *Paediatric Anaesthesia* 200;10:435-37
21. Burgard G, Mollhoff T, Prien T. The effect of laryngeal mask cuff pressure on postoperative sore throat incidence. *J Clin Anesth* 1996;54" 198-201.
22. Brimacombe J, Keller C. A comparison of pharyngeal mucosal pressure and airway sealing pressure with the laryngeal mask airway in anesthetized adult patients. *Anesth Analg* 1998;87:1379-82.
23. O'Kelly SW, Heath KJ, Lawes EG. A study of laryngeal mask inflation. *Anaesthesia* 1993;48:1075-8.
24. Nott MR, Noble PD, Parmar M. Reducing the incidence of sore throat with the laryngeal mask airway. *Eur J Anaesth* 1998;15:153-7.
25. Natalini G, Franceschetti ME, Pantelidi MT, et al. Comparison of the standard laryngeal mask airway and the ProSeal laryngeal mask airway in obese patients. *Br J Anaesth* 2002;90(3):323-6.
26. Grady DM, McHardy F, Wong J, et al. Pharyngolaryngeal morbidity with the laryngeal mask airway in spontaneously breathing patients: does size matter? *Anesthesiology* 2001;94(5):760-6.
27. Foley EP, O'Neill BL, Chang AS. The effect of duration of LMA exposure on the incidence of postoperative pharyngeal complaints. *Anesth Analg* 1995;80(S130):798.