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Review Article

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Postoperative sore throat: a systematic review

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Summary

Postoperative sore throat has a reported incidence of up to 62% following general anaesthesia. In adults undergoing tracheal intubation, female sex, younger age, pre-existing lung disease, prolonged duration of anaesthesia and the presence of a blood-stained tracheal tube on extubation are associated with the greatest risk. Tracheal intubation without neuromuscular blockade, use of double-lumen tubes, as well as high tracheal tube cuff pressures may also increase the risk of postoperative sore throat. The expertise of the anaesthetist performing tracheal intubation appears to have no influence on the incidence in adults, although it may in children. In adults, the i-gel™ supraglottic airway device results in a lower incidence of postoperative sore throat. Cuffed supraglottic airway devices should be inflated sufficiently to obtain an adequate seal and intracuff pressure should be monitored. Children with respiratory tract disease are at increased risk. The use of supraglottic airway devices, oral, rather than nasal, tracheal intubation and cuffed, rather than uncuffed, tracheal tubes have benefit in reducing the incidence of postoperative sore throat in children. Limiting both tracheal tube and supraglottic airway device cuff pressure may also reduce the incidence.

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Introduction

Postoperative sore throat is a common occurrence following general anaesthesia and, although clinicians often regard it as a relatively minor complication, patients perceive avoidance as being of great importance. Instrumentation of the airway is an inherent risk factor for the development of this common complication, yet a number of techniques can reduce the incidence. We performed a systematic review in order to assess the risk factors that increase the likelihood of postoperative sore throat in adults and children and the efficacy of interventions designed to reduce its incidence.

Methods

We independently and systematically searched the literature using MEDLINE and EMBASE bibliographic databases, the Cochrane Central Register of Controlled Trials (CENTRAL) and manually using the following search terms in either the title or abstract: endobronchial intubation; endotracheal intubation; nasotracheal intubation; intubation, intra-tracheal; supraglottic airway(s) device(s); LMA laryngeal mask Classic; Flexible LMA laryngeal mask; LMA laryngeal mask Unique; Portex SoftSeal; Ambu AuraOnce; Cobra perilaryngeal; cobraPLA; ProSeal LMA laryngeal mask; LMA laryngeal mask Supreme; LMA laryngeal mask Guardian;

g-LMA laryngeal mask; SLIPA; streamlined liner of the pharyngeal airway; i-gel; supraglottic gel device(s); sore throat and pharyngitis. Individual searches were, subsequently combined using AND/OR options. The following filters were then applied: publication date 01/01/2005 to 31/12/2015; English language; human subjects; adult subjects (age ≥ 18 years) and clinical trial. For the section on paediatrics, the same search was performed with the exclusion of adult patients (age < 18 years). Any trials that did not have postoperative sore throat as a primary outcome measure were not included (Fig. 1). These were then qualitatively supplemented by a manual search to include studies that were deemed relevant.

Postoperative sore throat following tracheal intubation in adults

Risk factors

Tracheal intubation is associated with a greater risk of postoperative sore throat than when either a supraglottic airway device or a facemask is used [1] and several risk factors have been identified. A prospective study of 809 patients found a 40% incidence [2]. Subsequent

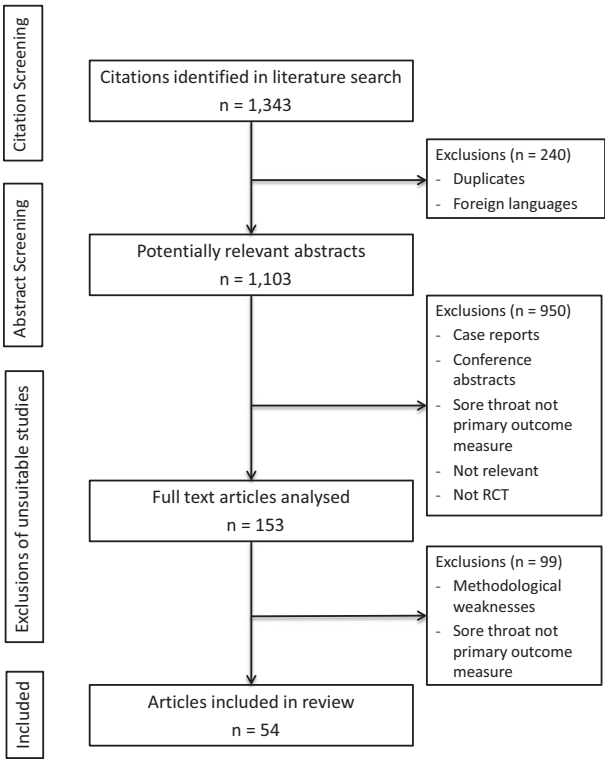

Figure 1 Study selection flow diagram.

logistic regression analysis demonstrated that female sex [odds ratio (OR) 1.66], pre-existing lung disease (OR 3.12), duration of anaesthesia (OR 1.27) and the presence of a blood-stained tracheal tube on extubation (OR 4.81) were all associated with the greatest risk of postoperative sore throat. In addition, age was inversely related to the risk [3]. Women may be more likely to report any postoperative complication, thereby potentially introducing reporting bias, which could account for the higher incidence seen in women [4]. A more likely cause, however, are the varying sizes of tracheal tubes used in trials and clinical practice. In a study by Biro et al., [2] 7.5-mm internal diameter (ID) tracheal tubes were used, and it is possible that they were too large for certain patients. This theory is supported by a study in which 89% of female patients underwent tracheal intubation with a 6.0-mm ID tracheal tube. The rate of postoperative sore throat was similar to that seen in the male patients, of whom 97% had an 8.0-mm ID tracheal tube (27% vs 38%, respectively, p = 0.20) [5]. A similar reduction in the incidence was seen in a randomised controlled trial that included 100 female patients when a 6.0-mm ID rather than a 7.0-mm ID tracheal tube was used (27.1% vs 51.1%, respectively) [6]. In addition, a subsequent meta-analysis of trials involving 509 female patients suggested that the use of 6.0 mm rather than 7.0-mm ID tracheal tubes reduced the incidence of postoperative sore throat both in the recovery unit and at 24 h postoperatively, with risk reductions of 0.56 and 0.69, respectively [7]. It may appear somewhat surprising that a 1-mm reduction in internal diameter should result in such a marked decrease in the rate of sore throat, since it is only the tracheal tube cuff that is in contact with the trachea. However, what patients describe as 'sore throat' encompasses a wide range of conditions including pharyngitis, laryngitis, tracheitis, cough, hoarseness or dysphagia. Smaller tracheal tubes subjectively provide a better view of the passage of the tube through the larynx, which may reduce the trauma associated with laryngoscopy and tube insertion [8].

The GlideScope® (Verathon Inc., Bothell, WA, USA) [9] and the Airway Scope (Pentax, Tokyo, Japan) [10] have both been shown to be associated with lower rates of postoperative sore throat when compared with direct laryngoscopy using Macintosh

blades. However, in both these studies, relatively large diameter tracheal tubes were used in female patients (7.0-mm ID and 7.5-mm ID) and tracheal cuff pressures were not accurately measured or monitored. The expertise of the anaesthetist performing tracheal intubation appears to have no effect as, in a retrospective review of 21,606 patients [3], consultants and trainees had a similar incidence of throat complications (32.6% vs. 32.9%, respectively).

Undertaking tracheal intubation without neuromuscular blockade increases the incidence of postoperative sore throat [11]. It has been suggested that the use of suxamethonium may increase sore throat, possibly due to fasciculation and subsequent myalgia of striated pharyngeal muscle fibres. A recent study, however, found a similar incidence and severity following the use of suxamethonium and rocuronium [12].

Double-lumen endobronchial tubes are associated with a greater risk of sore throat (OR 2.55) [13], although those made from silicon may have lower rates than polyvinylchloride [14]. In addition, insertion with the tracheal lumen facing anteriorly during passage through the vocal cords reduces rates by 50% [15]. A recent systematic review and meta-analysis demonstrated that bronchial blockers are associated with a lower incidence compared with double lumen tubes (OR 0.39) [13]; all types of bronchial blocker appear to be similarly efficacious in this regard [16]. The type of single-lumen tracheal tube has no effect [17].

Prevention

Lidocaine: A meta-analysis by the Cochrane Collaboration [18] reviewed 19 studies involving 1,940 patients that used lidocaine in several different ways and in a variety of concentrations: within the tracheal tube cuff (2–10%); applied as a gel on the exterior of the tracheal tube (4%); intravenously (1–1.5 $mg.kg^{-1}$) or as an aerosol spray (4–10%). Overall, topical and systemic lidocaine therapy appeared to reduce the risk of postoperative sore throat [risk ratio (RR) 0.64, 95% confidence interval (CI) 0.48–0.85]; however, when only the studies rated as being of high quality were analysed, this benefit was no longer observed (RR 0.71, 95% CI 0.47–1.09). Due to variations in study methodology and the differing doses and routes of administration, we cannot recommend lidocaine for the prevention of postoperative sore throat, and some additives in aerolised lidocaine may actually cause it [18]. Since the publication of the meta-analysis, three further studies have been published, involving a total of 370 patients, which have suggested that lidocaine is of benefit when directly applied to the glottis [19, 20] or administered within the tracheal tube cuff [21]. However, these studies are of low quality and the conclusions of the Cochrane group remain valid.

Steroids: Dexamethasone is the most popular steroid studied in this regard. A meta-analysis published in 2014 that included seven randomised controlled trials suggested that an intravenous dose greater than 0.1 $mg.kg^{-1}$ reduced the incidence and severity of postoperative sore throat at 24 h (RR 0.68 and standardised mean difference −1.15) [22]. The smallest tracheal tube used in these studies was 7.0-mm ID, one study used only double lumen tubes and tracheal cuff pressures were controlled in only one study. The application of triamcinolone paste (0.1%) to the tracheal tube and cuff was associated with a reduction in the incidence and severity of sore throat at 24 h compared with chlorhexidine gel [23]. Similarly, betamethasone gel (0.05%) reduced the incidence compared with 2% lidocaine gel [24]. Preoperative inhaled fluticasone [25] and budesonide [26] have also been shown to reduce the incidence and severity of postoperative sore throat.

Non-steroidal anti-inflammatory drugs (NSAIDs): The NSAID most commonly investigated is benzydamine hydrochloride, a topical preparation that also has antibacterial properties. A meta-analysis of benzydamine identified five randomised controlled trials that included 824 patients, one of which used supraglottic airway devices [27]. For the studies investigating tracheal tubes, benzyamine was sprayed directly onto the tracheal tube and/or into the oropharynx in three studies while the remaining study used a benzyamine gargle. The incidence of postoperative sore throat compared with control groups was reduced at all measured time points up to 24 h (RR at 1 h and 24 h were 0.42 and 0.32, respectively). A more recent study examined the effect of applying benzydamine to the oropharynx and

tracheal tube cuff of patients requiring double lumen tracheal tubes [28]. The incidence and severity of postoperative sore throat was reduced at 1 h, 6 h and 24 h; however, the reduction in severity of symptoms was modest, with a mean improvement in VAS scores of less than 13 mm in a scale of 0–100 mm. A pre-operative 350 mg aspirin gargle reduced postoperative sore throat, but only for 2 h [29]. Intravenous diclofenac had no effect in patients undergoing laparoscopic surgery [30], although topical diclofenac reduced the incidence of sore throat following caesarean section [31].

Tracheal tube cuff pressure: The monitoring and limitation of tracheal tube cuff pressure as a method to reduce postoperative sore throat has been extensively investigated because excessive cuff pressure can damage tracheal mucosa by direct trauma and reduction in blood flow. A prospective, randomised controlled trial compared tracheal tube cuff inflation using a manometer (pressure 15–25 mmHg) with manual palpation of the pilot balloon in 509 patients [32]. The cuff pressure, however, was not subsequently monitored during the remainder of surgery. The manometer group patients had a significant reduction in the incidence of sore throat at 24 h compared with control (34% vs 44%, respectively). Subsequent studies in patients having maxillofacial [33] and thyroid surgery [34] have confirmed that control of tracheal tube cuff pressure reduces the severity of symptoms for 2–6 h and the incidence of sore throat for up to 24 h.

Liquorice: Liquorice is derived from the root of Glycyrrhiza glabra and has been utilised in traditional and modern medicine because some of its ingredients are reported to have anti-inflammatory and antitussive properties. Agarwal et al. demonstrated a reduction in the incidence of sore throat for up to 4 h postoperatively following a gargle of 0.5 g liquorice in 30 ml water 5 min before induction of anaesthesia [35]. However, at 24 h postoperatively the incidence of pain at rest was the same as in the placebo group. In a larger cohort (n = 236) who underwent tracheal intubation with double lumen endobronchial tubes, the incidence of sore throat was reduced by around 50% in comparison with controls (21% vs. 45%, respectively; RR 0.48) [36]. Similar benefits were found in smokers who sucked liquorice lozenges 30 min before surgery [37].

N-methyl-D-aspartate (NMDA) receptor antagonists: The antinociceptive and anti-inflammatory effects of the NMDA receptor antagonists, magnesium and ketamine, have been investigated in attenuating the symptoms of postoperative sore throat. The sucking of a lozenge containing 610 mg magnesium citrate 30 min before surgery significantly reduced the incidence at 2 h and 4 h postoperatively when compared with a placebo lozenge (14% vs 40%, respectively at 4 h) [38]. By 24 h, however, the incidence of sore throat was similar in both groups. A magnesium gargle (20 $mg.kg^{-1}$) administered 15 min before appendicectomy reduced the incidence and severity of postoperative sore throat at 2 h, 4 h and 24 h compared with a ketamine gargle (0.5 $mg.kg^{-1}$) [39], although a pre-operative ketamine gargle (40 mg) was effective for 24 h in another study [40]. The mechanism of action of ketamine is likely due to a local effect, because an intravenous 0.5 $mg.kg^{-1}$ bolus and subsequent infusion had no effect on the incidence or severity of sore throat 24 h following cholecystectomy [41].

Others: Several other novel methods have been examined, including lozenges containing amyl-m-cresol (the active ingredient in Strepsils®), azulene and dexpanthenol [42–45]. Although the results of these trials all reported reductions in the incidence of postoperative sore throat, larger studies are needed to confirm the efficacy and safety of these agents. Premedication with oral clonidine 150 μg is ineffective and may exacerbate symptoms, presumably secondary to an antisialogogue effect [46]. Gabapentin 600 mg, 1 h before surgery reduced the incidence of sore throat at rest but not on swallowing in patients who had undergone thyroid surgery [47].

Postoperative sore throat following supraglottic airway device (SAD) use in adults

Supraglottic airway devices are used in approximately 56% of all general anaesthetics administered in the UK, of which 80% are first generation devices [48]. First-generation SADs lack design features to reduce

the risk of gastric aspiration while second-generation SADs offer improved safety against gastric aspiration and regurgitation, often have integral bite blocks and provide higher oropharyngeal leak pressures. Although the incidence of postoperative sore throat is lower compared with tracheal tubes, it still remains significant at up to 49% [49] and is affected by the choice of SAD, insertion technique and post-insertion management. Commonly performed trials compare the clinical characteristics of two or more devices; however, the primary outcome measure in the vast majority of studies is not postoperative sore throat. Although our search strategy identified two studies [50, 51] comparing the effect of SADs on postoperative sore throat as the primary outcome measure, for the purposes of comparison, we undertook a manual search and selection of studies we felt were relevant comparators. In these, the incidence of postoperative sore throat for each device varies markedly between trials; for example, the LMA® laryngeal mask[1] Classic (Teleflex Medical, Morrisville, NC, USA) has a reported incidence between 2.6% [52] and 42% [53]. This disparity is probably attributable to differences in quantifying postoperative sore throat and/or different study methodology.

Choice of SAD

When comparing the LMA laryngeal mask Classic™ with the single use Portex® Soft Seal® (Smiths Medical, St. Paul, MN, USA), Tan et al. [54] found no difference in postoperative sore throat incidence, although this was in contrast to a number of older studies [55–57]. When comparing the Soft Seal® and the LMA laryngeal mask Unique™ (Teleflex Medical), one study found a higher incidence in the Soft Seal group [58], while another found no difference [59]. The Cobra perilaryngeal airway (CobraPLA®, Pulmodyne, Indianapolis, IN, USA) also has variable results [60–62] and it is likely that there is little difference in postoperative sore throat incidence when comparing first-generation SADs.

Second-generation SADs have a more compelling evidence base. Numerous studies have demonstrated a reduction in postoperative sore throat when using the i-gel™ (Intersurgical, Wokingham, UK) [50, 63–65], although few demonstrated equivalent outcomes to other SADs [66]. A meta-analysis found no difference in the incidence between the ProSeal LMA laryngeal mask™ (Teleflex Medical, NC, USA) and the LMA laryngeal mask Supreme™ (Teleflex Medical) [67]. The ProSeal LMA laryngeal mask has a similar sore throat profile to that of the LMA laryngeal mask Guardian™ (Teleflex Medical) [68], and possibly the i-gel [69, 70] but has a variable evidence base when compared with the streamlined liner of the pharynx airway (SLIPA™, CurveAir Ltd, London, UK) [71, 72]. There was no significant difference with the LMA laryngeal mask Supreme and the SLIPA compared with the LMA laryngeal mask Classic™ [73, 74]. The incidence of postoperative sore throat with the Ambu® AuraOnce™ (Ambu, Ballerup, Denmark) is also comparable to first generation SADs, including the LMA laryngeal mask Classic, LMA laryngeal mask Unique and the Soft Seal LMA laryngeal mask [75], but higher than the i-gel [76].

The available evidence suggests that there is little difference in the incidence of postoperative sore throat between first- and second-generation SADs, with the exception of the i-gel, possibly due to the absence of an inflatable cuff.

Insertion technique

Multiple modifications in the recommended LMA laryngeal mask Classic insertion technique (placing a fully deflated, lubricated device with the index finger) have been attempted in order to increase success rate and reduce the incidence of laryngopharyngeal complications. Supraglottic airway device insertion with a fully inflated, rather than a fully deflated, cuff was found to reduce the incidence of postoperative sore throat, with less blood staining on removal of the device [77]. An alternative strategy involves inserting a deflated SAD without using an index finger but, although a more appealing technique, this has a similar insertion success rate to the manufacturers' recommended method and the same incidence of postoperative sore throat [78]. Interestingly, inflating the SAD cuff *after* securing the device has been shown to reduce the incidence when compared with the traditional method of securing the device after inflating the

[1] LMA is a registered trade mark of The Laryngeal Mask Company Ltd, an affiliate of Teleflex Incorporated.

cuff [79]. In one study, a laryngoscope-guided technique to insert flexible SADs reduced the incidence of postoperative sore throat from 35.2% to 16.7% when compared with the standard insertion technique [80]. The ProSeal LMA laryngeal mask is more difficult to insert than the LMA laryngeal mask Classic [81] and different insertion techniques have been developed. With the standard approach, there is a sore throat incidence of up to 33% [82], which was reduced to 25% when an introducer was used [83]. The 90° rotational technique is an alternative method, whereby the device is inserted in the midline, following which the shaft is rotated 90° counter-clockwise until resistance is encountered, then the device is rotated clockwise back to the midline. This has a greater insertion success rate, as well as a significantly lower incidence of postoperative sore throat (between 9% and 12%) [81, 82]. The use of a gum elastic bougie to guide ProSeal LMA laryngeal mask insertion has a lower incidence of sore throat when compared with the finger insertion technique [83, 84], and the same holds true when using a stylet [85]. Alternative insertion methods have not demonstrated a reduction [86, 87].

Cuff pressures

Most manufacturers recommend that SAD cuff pressures should not exceed 60 cmH_2O. An increasing body of evidence suggests that high cuff pressures contribute significantly to laryngopharyngeal complications, including postoperative sore throat. The LMA laryngeal mask Classic is the most studied device and monitoring and maintaining a cuff pressure of 60 cmH_2O or lower is associated with a significant reduction in sore throat [88–93]. The effect of cuff pressure is less obvious in other SADs. For example, a study comparing high and low cuff pressures using the ProSeal LMA laryngeal mask found no statistically significant difference [94]. The CobraPLA, which is larger than the LMA laryngeal mask Classic size for size, was studied and low cuff pressures reduced the incidence of moderate sore throat, although mild and severe pain was the same [95]. Using cuff pressures in the LMA laryngeal mask Supreme of 25 cmH_2O resulted in a reduced incidence of postoperative sore throat [96]. These data are from a small study in patients undergoing laparoscopic surgery (n = 98), but suggest that pressures significantly lower than 60 cmH_2O may be preferable.

Various alternatives to the recommended water, water-based gel or saline lubricants have been investigated. Nasseri et al. [97] compared lubricating the LMA laryngeal mask Classic with either lidocaine 2% or standard lubricant gel and found no difference in the incidence of postoperative sore throat. A betamethasone 0.05% gel was found to be superior to lidocaine 2% gel [98]. Other studies found no benefit with alternative lubricants [99] or humidification techniques [100].

Others

The pre-operative administration of a flurbiprofen lozenge reduced the severity, although not the incidence, of early postoperative sore throat [101]. A pre-operative 2 $mg.kg^{-1}$ tramadol gargle reduced both the incidence and severity of sore throat for up to 24 h postoperatively in a small study of 50 patients [102], although 100 mg of intravenous hydrocortisone had no effect [103]. Diffusion of nitrous oxide into the cuff led to an increase in cuff pressure of up to 250% [104] and resulted in an increased incidence of postoperative sore throat [91]. Neuromuscular blockade before the insertion of a ProSeal LMA laryngeal mask doubled the incidence of sore throat [105]. The use of propofol is associated with a better laryngopharyngeal morbidity profile compared with sodium thiopental when using a SAD [106] and has a more favourable outcome when used for anaesthesia maintenance compared with sevoflurane [107].

Postoperative sore throat in children

The Royal College of Anaesthetists (RCoA) state that 'For a child in good health having minor surgery one child in ten experiences a headache or a sore throat' [108]. At the Evelina London Children's Hospital, a postoperative sore throat incidence of between 1% and 10% is quoted [109]. The incidence appears to be lower in children compared with adults, but it is difficult for a small child to specifically express their discomfort, which may manifest as agitation, crying or restlessness and even be misinterpreted as emergence delirium [110] or wound pain [111]. The incidence, as in adults, is much higher if the child or parent/carer is specifically questioned [112]. The severity is traditionally categorised on a four-point scale as described by Stout et al. [113] but this scale is

not very useful in children. It is usually at its worst 4 h postoperatively but may persist for up to four days [114].

Pre-operative risk factors

Pre-operative risk factors such as asthma or dry cough make the patient more susceptible to peri-operative adverse respiratory events, including sore throat [115]. Children with an upper respiratory tract infection are significantly less likely to have sore throat and other postoperative respiratory complications when an SAD is used [116], although a study in children with minor upper respiratory tract infections requiring ophthalmic procedures found no difference when compared with the use of a facemask [117].

Prevention

The pre-operative use of an antisialogogue (glycopyrrolate) resulted in postoperative sore throat in 13.3% of children [118]. Local anaesthetic gel applied to an airway device or spraying of the mouth with local anaesthetic may appear attractive but a commercial lidocaine throat spray caused more postoperative problems than saline spray, again, possibly due to irritant additives within the spray itself [119].

Tracheal tubes

When inserting a tracheal tube, postoperative throat complications are, intuitively, more likely [120]. For example, there may be coughing or movement due to inadequate anaesthesia or neuromuscular blockade, glottic exposure may be difficult, and airway trauma is more common. Operator experience may play a part rather more so than in adults. Supraglottic airway devices caused less sore throat than nasotracheal tubes in children aged 2–7 years having day-case dental surgery [121]. In a meta-analysis of 16 studies, comparing SADs with a tracheal tube, the overall incidence of postoperative sore throat was 9.8% vs 15.3%, respectively [122]. This contrasts with a quantitative meta-analysis of respiratory complications from 19 studies that compared SAD with tracheal intubation [123]. Although the incidence of desaturation, laryngospasm, coughing and breath holding were lower when a SAD was used to secure the airway, the incidence of sore throat (OR 0.87; 95% CI 0.53–1.44) was similar. Nasotracheal is associated with more sore throat than orotracheal intubation. Following general anaesthesia for dental surgery, children whose tracheal intubations were traumatic were more likely to report postoperative sore throat [124].

In a study of 111 children, 37% of those intubated with an uncuffed tracheal tube complained of sore throat compared with 19% with cuffed tracheal tubes [125]. Furthermore, the incidence of sore throat correlated with increased cuff pressure: 4% at cuff pressures of 11–20 cmH_2O; 20% at 21–30 cmH_2O; 68% at 31–40 cmH_2O; and 96% at cuff pressures of > 40 cmH_2O.

Supraglottic airway devices

The paediatric i-gel has the same design as the adult device and has potential to cause less postoperative

Table 1 Potential risk reduction interventions for postoperative sore throat.

Tracheal intubation	SADs	Children
Smaller tube size [5–7]	Use of i-gel [50, 63–65]	SAD rather than tracheal tube [121, 122]
Video laryngoscopy [9, 10]	90° rotational insertion technique, use of introducing stylet for ProSeal LMA laryngeal mask [81–85]	Oral rather than nasotracheal intubation [124]
Limiting cuff pressure [32–34]	Cuff pressure limitation ≤ 60 cmH_2O [88–93, 96]	Cuffed rather than uncuffed tubes [125]
Intravenous, topical or inhaled steroids [22–25]	Topical steroids, NSAIDs, tramadol [98, 101, 102]	Limiting tracheal tube cuff pressure [126]
Topical NSAIDs [27–29, 31]	Propofol induction and maintenance [106, 107]	SAD cuff pressure limitation ≤ 60 cmH_2O [130–133]
Liquorice, magnesium and ketamine gargle [35–40]		

NSAIDs, non-steroidal anti-inflammatory drugs; SAD, supraglottic airway device.

sore throat because there is no cuff inflation. The i-gel has been compared with the ProSeal LMA laryngeal mask, the LMA laryngeal mask Classic [126], the LMA laryngeal mask Supreme [127] and the PRO-Breathe® silicone disposable SAD (Well Lead Medical Co Ltd, Panyu, China) [128] in both spontaneously breathing and patients who received neuromuscular blockers, but these studies were not sufficiently powered to detect a difference in complication rates. However, Smith and Bailey [129] found that there was no difference in the overall incidence of postoperative sore throat between the i-gel and different SADs when data were pooled.

As with adults, most manufacturers recommend cuff inflation with a maximum volume of air or to a maximum pressure of 60 cmH_2O. Inflation to a pressure less than the manufacturers' recommendations still allows adequate ventilation with minimal leakage [130]. Four hundred children receiving an SAD were studied and 45 (11.25%) developed sore throat, of which 56.5% had cuff pressures exceeding 100 cmH_2O [131]. The incidence was zero when cuff pressures were less than 40 cmH_2O. It has been suggested that, particularly for the smaller sizes, SADs should be deflated following insertion, rather than inflated, in order to avoid cuff hyperinflation [132]. The use of nitrous oxide significantly increases cuff pressures and, in one study, the incidence of postoperative sore throat was 45% compared with 5% in the group receiving air [133].

When using flexible SADs, introducers may be used to facilitate insertion and do not appear to increase the incidence of sore throat [134]. However, using flexible laryngeal masks with a polyvinyl chloride surface was associated with a significantly higher risk when compared with a silicone surface. As with cuffed tracheal tubes, when using cuffed SADs, cuff pressures should be monitored in order to minimise pressure-related airway complications.

Conclusion

Postoperative sore throat is largely self-limiting and most interventions only result in a minor reduction in the severity of symptoms (Table 1). The risk following tracheal intubation is most likely to be minimised by using the smallest tracheal tube practically possible (especially in female patients) and monitoring cuff pressure. Insertion techniques may affect the incidence of postoperative sore throat when using SADs, but the most significant factor is excessive cuff pressure and, therefore, the i-gel has the most favourable profile in adults. Postoperative sore throat in children is a significant complication and the risk should be explained to the child and parent/carer preoperatively. Use of oral tracheal tubes results in less sore throat than nasal tracheal tubes and cuffed ones are less likely to cause postoperative sore throat compared with uncuffed tubes, provided cuff pressures are monitored.

Competing interests

CRB and MDW are Editors of *Anaesthesia* and this article was externally reviewed. No external funding or other competing interests declared.

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