# Comparison of Supraglottic airway devices for airway management during surgery in children: A review of literature

**Authors: Mir Ahmad Hendinezhad[1], Anahita Babaei[2*], Afshin Gholipour Baradari[3], Alieh Zamani[2]**

[1]Anesthesiologist, Sari, Iran

[2, 2*]Department of Anesthesiology, Faculty of Medicine, Mazandaran University of Medical Sciences, Sari, Iran

[3]Department of Anesthesiology, Faculty of Medicine, Mazandaran University of Medical Sciences, Sari, Iran

2*- **Corresponding author:** Anahita Babaei, Assistant Professor, anesthesiologist

**Postal address:** Department of Anesthesiology, Imam Khomeini Hospital, Amir Mazandarani Boulevard, Sari, Iran

**Tel & Fax:** +98 33361701-4

**Email:** Babaeianahita112@gmail.com

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## Abstract

**Context:** Supraglottic airway devices (SADs) in airway management during and emergency conditions in pediatric.

**Objective:** The objective of this review was to examine the literature that evaluated pediatric supraglottic airway devices, to find the optimal device exists in term of oropharyngeal leak pressure (OLP), risk of insertion failure at first attempt and risk of blood staining of the device.

**Data Sources:** An electronic search was conducted of MEDLINE, EMBASE, CINAHL and pubmed databases. We also searched the Cochrane database (CENTRAL) and Web of Science up to July 1, 2017.

**Study Selection:** Of 112 potential studies; the full texts of 53 articles were existed in detail; in which 15 were duplicated and was omitted from the study. Papers which were not directly discussed SADs were also excluded. In total, 30 papers were identified which were related to the Children supraglottic devices.

**Data Extraction:** The current review was conducted and reported in accordance with the Preferred Reporting Items for systematic reviews and meta-analyses (PRISMA) statement.

**Results:** We found that the LMA-Proseal may be the best supraglottic airway device for children up to now due to its high OLP and a low risk of insertion failure. Although the i-gel seems a very functional tool either.

**Conclusions:** We recommend that there is a need for more research to find out which supraglottic airway provides the best devices in diverse clinical situations and with children of various conditions.

**Keywords:** Supraglottic airway device, Children, Fiberoptic bronchoscopic view, Oropharyngeal leakage pressure

## 1. Context

Supraglottic airway devices (SADs) have been widely used for airway management (1). Children who are candidate for surgeries are among whom benefit most from SAD usage. There are many supraglottic airway (SGA) devices which are used for the management of a difficult airway and as a tool for tracheal intubation conduit in children (2). Advantages of the endotracheal intubation assisted by SADs has been well documented including effortless insertion, improved alignment of the glottis opening, and continuous patient oxygenation and ventilation. In addition, the intubation related hemodynamic stress response by SAD is less than common methods (3) and these devices can be an excellent alternative for patients with previous history of difficult intubation, limited neck movement, and unstability of cervical spine (4). Moreover, SAD provides the ability to overcome upper airway obstruction and provision of a hands-free airway with a relatively straight forward path to the larynx (5). However, despite all evidences, determining the optimal SAD is complicated.

## 2. Objective

The objective of this review was to examine the literature that evaluated pediatric SADs, to develop recommendations for future study and integrity of evidences.

## 3. Data Sources

To establish a thorough review of the relevant literature, the following steps were taken. An electronic search was conducted of MEDLINE, EMBASE, CINAHL and pubmed databases. We also searched the Cochrane database (CENTRAL), and Web of Science up to July 1, 2017.

## 4. Study Selection

With this focus, papers that studied subgroups such as the comparison of devices in children and experiences of their usage was included. The key words used for the search strategy were: supraglottic device, supraglottic airway device, laryngeal mask, children, child, and pediatric. A review of reference lists of articles was performed to identify further references.Two authors independently scanned the titles and abstracts identified by the variety of search strategies described above. All randomized trials comparing any types of supraglottic airway device in children were included. Similarly, studies of cost effectiveness and case reports of rare complications in the emergency ward were also included in this review to consider every possibility of adverse effect for clinicians.

## 5. Data Extraction

Of 112 potential studies; 53 paper's full text were accessible. Initially, the full-text versions of potentially eligible studies chosen by at least one reviewer were assessed. Any disagreement was resolved by discussion. Eligibility was restricted to English language. Data were then extracted into prepared data extraction tables. We extracted data on patient frequency, type of laryngeal mask airway (LMA), study design and predominant findings. Finally, a structured narrative

summary of the studies was conducted using 30 papers identified which were related to the Children supraglottic devices.

## 6. Results

A comprehensive search was conducted. The following SADs were included in this review: LMAClassic; LMA Proseal; LMA Supreme; LMA Flexible; LMA Unique; i-gel; Laryngeal Tube™; self pressurised air-Q™; Cobra perilaryngeal airway™ and Ambu Aura-i™. In total, 30 papers were identified which were related to the Children supraglottic devices. These qualitative studies were conducted at various settings, including emergency and accident ward or operating rooms. A review of recent literatures is discussed on table 1 and further argued through the article.

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**Table 1.** Characteristics of the papers on pediatric LMAs practice

| **Source** | year | F | Device | Approach | Result |
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| **Ahn(6)** | 2016 | 789 | Air-Q (air-Q) | meta-analysis | AirQ had no difference in term of leakage pressure and insertion time with classic form, notably lower ease of insertion, lower success rate and better fiberoptic bronchoscopic view (FBV). |
| **Jagannathan(1)** | 2010 | 100 | air-Q™ | prospective | Main finding were easy placement, quick removal of the Intra Laryngeal airway (ILA) after successful intubation without dislodgement of the tracheal tube and reccomendation of fiberoptic bronchoscopy foraiding tracheal intubation insertion through this device. |
| **Darlong(7)** | 2015 | 64 | air-Q vsAmbu Aura-i | prospective | Air-Q ILA provided significantly higher OLP than the Ambu Aura-I but higher time for insertion. No differences in first insertion success rate, FBV, and postoperative complications. |
| **Jagannathan(8)** | 2012 | 50 | Supreme™ vs Unique™ | Clinicaltrial | LMA Unique was better in time for insertion. Airway leak pressures for the Supreme and Unique were 20 and 15 cmH2O. Gastric insufflation was lower with the Supreme. Supreme performed as well as Unique especially by evacuation of gastric contents during anaesthesia. |
| **Brueggeney(9)** | 2015 | 80 | Ambu Aura-i | clinicaltrial | Blind intubation was possible in 15% with the Air-Q and in 3% with the AmbuAura-i. Rates |

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| | | | vsAir-Q | | ofinsertion success were 95% (Air-Q) compared to 100% (AmbuAura-i). There was no difference in FBV. Fibreoptic guidance is recommended with both devices. |
| **Pejovic(10)** | 2016 | 25 | i-gel LMA vs face mask | Manikinstudy | In all three occasions, personnel succesfuly inserted i-gel, but the face mask was not effective enough in maintaining positive pressure ventilation and first, second and third attemptssucsess. |
| **Beylacq(11)** | 2009 | 50 | i gel | prospective, observational | Devices insertionwerecompletely succesfulat the first attempt. The mean seal pressure was 25 cmH2O and gastric inflation were not seen. |
| **Bortone(12)** | 2006 | 30 | laryngeal tube (LT) vs classic LMA | prospective | LMA showed better efficacy compared with LT group in achiving spontaneous or assisted ventilation after initial positioning and after head extension or device. Moreover LMA group had better FBV than LT group. |
| **Jagannathan(13)** | 2011 | 2 | air-Q ILA | case report | In both cases of failed laryngoscopy in pediatric patients with blood in the airway; successful blind tracheal intubation via the lumen of the air-Q ILA was done. |
| **Szmuk(14)** | 2005 | 1 | cobraPLA™ | case report | The study was the first report of successful management of difficult airway mask ventilation. |
| **Baker(15)** | 2010 | 100 | cLMA™, AmbuAura OnceTM, PortexSoftSeal™, Bossilicone LM LMA Unique™ | clinical trial | Resistance to bronchoscope manipulation during flexible bronchoscopy was higher using Ambu, Unique™, and Portex than cLMA™.The Unique™ and Ambuwere clinically inferior to the cLMA™ at all levels of the airway. Single-use LMAs were inferior to the cLMA™ and laryngeal masks for flexible bronchoscopy in children. |
| **Gaitiani(16)** | 2008 | 80 | Airway-Unique | prospective cohort | Cuff seal pressure and endtidal CO2 were significantly higher for CobraPLA™ than for LMAU. Oxygenation, respiratory variables, |

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| | | | (LMA U) vs Cobra PLA™ | | time and ease of insertionwere similar in both. Fiberoptic scores were excellent with both devices. There was a low rate of blood mucosal staining and no sore throat of the devices. |
| **Goyal(17)** | 2012 | 120 | size 2 i-gel vsProSeal laryngeal mask airway (PLMA) and Classic – laryngeal mask airway (cLMA) | Prospective cohort | Success rate for first attempt was 95% for the i-gel group and 90% for the two laryngeal mask airway groups. There were no clinically important complications in the postoperative period. Pediatric size 2 i-gel is easy to insert and provides higher OSP compared with same size PLMA and cLMA in spontaneously breathing children undergoing elective surgery. |
| **Hughes(18)** | 2012 | 154 | i-gel | Observational | First insertion attempt was successful in 93.5% of patients, and second attempt in 5.8%. Leak pressure was 20 cmH20.Gastric tube in 90% of cases was inserted. On fiberoptic examination, the vocal cords were visible in 97% of patients. Complications arose in 20% of patients, but the majority were minor. Anesthetists commented that the device had a tendency to displace upward out of the mouth and that extension toward the forehead and flexion toward the feet of the proximal tube altered the quality of the airway. |
| **Yeoh(19)** | 2015 | 70 | i-gel | Case series | Insertion success rate andtime were 96 % and of 25s. Complication occurred in 24.3 % of cases. Optimizing ventilation with i-gel was possible. |
| **Jagannathan(20)** | 2012 | 168 | i-gel™vs Supreme | Clinical trial | Airway leak pressure, number of attempts and insertion time for the i-gel was higher than with the Supremebut There were no differences in the time for device insertion, fiberoptic grade of view, quality of airway, and complications. |

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| **Nirupa(21)** | 2016 | 100 | i-gel™ vsProSeal™ | Prospective | The olp IN i-gel™ group was 29.5 ± 2.5 cmH2O as compared to 26.1 ± 3.8 cmH2O in PLMA™ group. Insertion time and quality of initial airway was greater with i-gel™ but number of attempts, ease of insertion of supraglottic device, insertion of orogastric tube and pulmonary mechanics were similar. |
| **Jagannathan(22)** | 2012 | 100 | i-gel™ vsSupreme | Prospective cohort | The leak pressures (22), posibility of gastric decompression and insertion success rate suggest that the Supreme may be a more effective device for positive pressure ventilation in children. |
| **Jagannathan(23)** | 2009 | 5 | air-Q | Case series | The study showed a case series of patients with anticipated difficult airway in whom the air-Q ILA was successfully used as a conduit for fiberoptic intubation. |
| **Jagannathan(24)** | 2011 | 354 | air-Q ILA_ (ILA-SP) | Prospective cohort | Three patients required conversion to a standard laryngeal mask airway or a tracheal tube. The mean initial airway leak pressure for all patients was 17.8, and 20.4 when re-checked at 10 min. Complications were limited to 14 patients . |
| **Jagannathan(25)** | 2012 | 120 | Aura-i vs the air-Q | Prospective | There were no differences in the time to successful insertion, leak pressure and time of removal. However, with the size 1.5 Aura-i, the pilot balloon of the tracheal tube was removed in order to facilitate the removal of the device after tracheal intubation. |
| **Jain(26)** | 2015 | 30 | i-gel™ | Prospective cohort | OPLP was significantly higher in flextionand lower in extension in comparison to the neutral position but worsening of the fiberoptic view and ventilation in flexion compared to neutral position. |
| **Sunder(27)** | 2012 | 90 | flexible laryngeal mask airway (LMA$^{TM}$) vsCobraPLA$^{TM}$ | Prospective cohort | A higher incidence of intraoperative device displacement was noted with the CobraPLA$^{TM}$ in comparison to flexible LMA$^{TM}$ especially in strabismus surgery.Insertion characteristics and ventilation parameters were equivalent. Higher surgeon discontent was seen in the Cobra group. |
| **Kelly(28)** | 200 | 100 | ProSeal | Prospective | The overall first attempt success rate was 93% |

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| | 8 | | LMA | cohort | .Median leak pressure was 25 cmH2O. No episodes of regurgitation and complication were recorded. |
| **Kim(29)** | 2015 | 80 | i-gel™vs the self-pressurized air-Q™ | Clinical trial | The i-gel had easier insertion and better sealing, and the air-Q improved fiberoptic views. |
| **Kus(30)** | 2014 | 60 | i-gel™vs Supreme LMA | Clinical trial | OLP and first attempt success rate for the LMA-S was significantly higher than with the I-gel. Insertion timeof the LMA and gastric tube for the LMA-S was shorter than I-gel but fibreoptic laryngeal views were similar in both groups. |
| **Al-Mazrou(31)** | 2010 | 60 | ETT vs LMA | Prospective cohort | LMA is a suitable tool for pediatric patients undergoing sinonasalsurgery because of good airway protection from blood contamination. |
| **Mitra(32)** | 2012 | 60 | size 2.5 i-gel vsProSeal LMA | Prospective cohort | Hemodynamic parameters, ease of insertion and postoperative complications were similar between the i-gel and PLMA, but the airway sealing pressure was significantly higher in the i-gel. |
| **Pandey(33)** | 2015 | 60 | Air Q vs ETT | Prospective | The Air-QILA is an easy to place SAD with tremendous airway seal and low airway morbidity. It may be useful as a conduit for blind orotracheal intubation in supine position and can be used as an effective alternative to FOB in low resource settings. |



Reviewing recent literature, at a glance, show that SADs like the i-gel, LMA-Proseal and Cobra perilaryngeal airway had a higher OLP in most studies focusing on OLP. Evidences also revealed that the risk of device failure may be lower with LMA-Proseal, LMA-Classic and LMA-Unique (34-36), but higher with i-gel (37, 38). Moreover, the risk of blood staining of the device was greatly poorer with the i-gel compared with LMA-Classic and LMA-Proseal.

In sum, the LMA-Proseal seems to be the best supraglottic airway device for children because of its high OLP and a low risk of insertion failure. Although the i-gel appears also a very functional tool either.

### 7.1. Outcome measures for rating success in LMA insertion

#### 7.1.1. Cuff Pressure

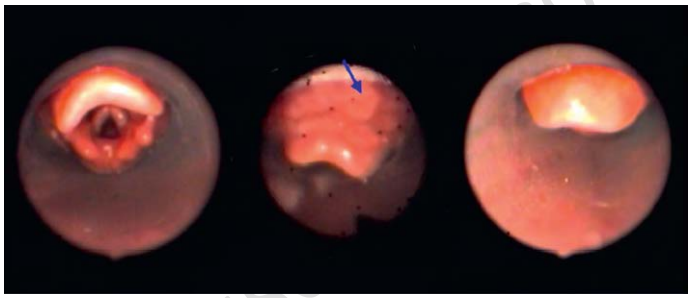
When the supraglottic cuff pressure is more than the mucosal perfusion pressure, it is expected to cause postoperative pharyngolaryngeal symptoms like sore throat (dysphagia or dysphonia) or local mucosal trauma and nerve injuries (39). SGAs with inflatable cuffs are susceptible for over inflation and may cause pressures higher than 60 cm H2O (40). Elevated pressures do not provide either better seal, and on the contrary are liable to cause more morbidity (41, 42).

### 7.1.2. Oro-pharyngeal seal pressure (OSP)

An effective seal of the glottis is necessary for effective ventilation. Moreover,good seal facilitate maintenance of the preferred depth of anesthesia without polluting the environment with the leaked gases and lessen leaks into the esophagus that prevent rise of intragastric pressure and risk of regurgitation (43).

### 7.1.3 Fiberoptic View through a SupraglotticDevice

Most studies have correlated the fiberoptic broncoscopic view (FOB) through the SGA with ease of ventilation, intubationand ventilation (36). However, the FOB scoring has now been challenged as adependable tool for SGA positioning (17).



Fiqure 1: The positioning of LMA; using the fiberoptic score suggested by Cook and Cranshaw (44). Left to right show View I (I = ideal), View H (H = too high) and View L (L = too low) respectivly; Arrow = lingual tonsil.

Further evidence about FOB in different studies demonstrated in table 1. Although a full glotticview may be unnecessary for primary ventilation, it is recommendedin order to avoid possible trauma.

### 7.1.3. Problems and Failure

Airway obstruction can arise due to malpositioning, obstruction by the epiglottis, laryngospasm, biting, or kinking of the tube. Light plane of anesthesia can also lead to laryngospasm and airway obstruction in children (37). Lingual edema and aspiration of stomach contents are other potential complication. Whatever younger and smaller the child, the higher the risk of problem (25, 30). There was a significant decrease in problems with increasing experience (18).

## 8. Discussion

In this study, our main findings were as follows: the i-gel, LMA-Prosealand Cobra perilaryngeal airway had a higher OLP than the other devices; the risk of device failure may be lower with LMA-Proseal, LMA-Classic and LMA-Unique (34, 35), but higher with i-gel (37, 38). On the other hand most studies' findings showed that the risk of blood staining of the device was considerably lower with the i-gel compared with LMA-Classicand LMA-Proseal (40). Although high quality randomized trials are needed to confirm the Laryngeal Tube results. Because a variety of new SGAs for use in children have emerged since their introduction into practice and assessing their possible pros and cons of each device thorough clinical evaluations remains important. Table1 summarizes the SGAs discussed and outlined potential areas of concern. Despite the many new devices, the cLMA, ProSeal, and Unique are still the best devices in pediatric use in different situations. The cLMA has been the standard SGA for many years but since 2003, many other 1st generation devices have been available in small sizes with further features and better performance (18, 30, 45). For example, the Cobra PLA was designed to be positioned in the hypopharynx and is composed of a breathing tube with a wide distal end which has a number of slots or bars (46). A cuff is attached proximal to the wide part, and when inflated serves to seal off the distal end from the upper airway and a softened 'tongue', which bend in the direction for better passage (16).Variations of LMAs like ProSeal, Unique, Supreme, and iLMA have been marketed in practice and discussed in the literature (47). The i-gel is a fairly exceptional SAD with a gel-like thermoplastic non inflatable cuff (48) which achieve an effective perilaryngeal seal because of its feseability to shape patient's airway structure (20). In addition, the device has a bite block and a buccal cavity stabilizer that stop the device malrotation and a gastric channel (22). The efficacy and safety of the device is discussed in recent studies; for example Pejovic (2016), in a manikin study, compared i-gel with face mask and reported that the I-gel accomplished a 100% success rate on all occasions bytranies (10). Yeoh, et al (2015) also found size 2 i-gel™'s superior advantages in pediatric interm of ease of insertion and low number of attempts (19). Novel design of the i-gel made it a suitable tool with good OLP and low risk of complication.

LMA Supreme is like to ProSeal LMA excepting its single usage and its shaft which works like an introducer. Various studies have shown good airway characteristics with LMA Supreme in children (20, 22, 35, 36). Jagannathan et al (49) found it comparable with the ProSeal LMA and Francksen et al. with the i-gel and recommended it as an useful alternative to ProSeal LMA (50). In a prospective cohort study Gaitini et al. compared Supreme size II with the ProSeal LMA and found it similarly effective with higher oropharyngeal seal pressure during spontaneous ventilation in children (51) that make it an optimal tool in the difficult or emergency airway managment.

The air-Q™ LMA is also a new SAD that allows passage of cuffed tracheal tubes and has the option for successive removal. In addition, the airway tube is broader, more rigid, and curved. AirQ features facilitate the use of the ILA as a conduit for tracheal intubation (23). Finally, The Ambu Aura-i is easy to insert and provides equal or better OSP than CLMA and unique, respectively, in adults (52, 53). It is also a suitable tool for blind endotracheal intubation (44).

Therefore, it has become a commonly used device for various short surgical procedures even in children. There is no doubt that these devices are appropriate for children undergoing many procedures. We recommend that there is a need for more research to find out which supraglottic airway provides the best devices in diverse clinical situations and with children of various conditions.

## 9. Conclusion

In term of new generation devices, we conclude that theLMA-Proseal andi-gel may be the most optimal supraglottic airway device for children as they have uniqe features that make them optimal; but still there is scarce body of knowledge and moreresearchess must be done to find out which supraglottic airway provides the best devices in diverse clinical situations and with children of various conditions.



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