INTRODUCTION

Airway management is an important aspect of anesthesia and critical care practice. Maintaining a patent airway becomes more essential when the surgery is being performed in the positions other than supine. The situation would become a nightmare if inadvertent extubation occurs in prone position intraoperatively, and would require immediate intervention to maintain a patent airway. There are anecdotal case reports of accidental extubation in a prone position, which were emergently managed by inserting various types of supraglottic airway devices (SADs).

ABSTRACT

Background: Accidental extubation during surgery in prone position can be life-threatening. Supraglottic airway devices (SAD) have been used successfully in such situations to rescue the airway. However, which SAD would be most appropriate in this setting has not been described in the literature. Aims: The aim of our study was to determine the most appropriate SAD for securing airway in a prone position during accidental extubation. Materials and Methods: In the study, Airway Trainer (Laerdal) manikin was used for studying insertion of three SADs; I-gel, Laryngeal Mask Airway ProSeal™ (PLMA) and LMA Classic™ (CLMA) in the prone position. Forty anesthesia resident doctors participated in this study. The time taken for insertion; ease of insertion and ventilation; bronchoscopic view; and insertion score were compared among the three groups. Results: The time taken for I-gel insertion was significantly lesser (12.89 ± 3.94 seconds) as compared to CLMA (17.07 ± 3.5 seconds) and PLMA (25 + 4.78 seconds). Least resistance was encountered in the insertion of I-gel, while maximum resistance was experienced in PLMA group (22.3% vs. 90%). The maneuver required for optimal positioning was observed in 27.5% of PLMA insertion, 2.5% in CLMA while no maneuver was required in any of the I-gel insertion. Ease of ventilation was comparable in all three SADs. The bronchoscopic view and insertion score were significantly higher with I-gel as compared to CLMA and PLMA. Conclusion: All three SADs were successful as rescue devices during accidental extubation in the prone position. However, the ease of insertion was maximum with I-gel, followed by CLMA and PLMA.

Key Words: Patient position, prone, supraglottic airway device, tracheal extubation

Comparison of three supraglottic airway devices for airway rescue in the prone position: A manikin-based study

Babita Gupta, Surender Gupta, Bijaya Hijam, Pallavi Shende, Vimi Rewari

Department of Anaesthesiology, Pain Medicine and Critical Care (JPNATC), AIIMS, 1Department of Anaesthesiology, Pain Medicine and Critical Care, AIIMS, New Delhi, India
and managing the airway is not as easy as it seems; it is not only
time-consuming but cumbersome too, particularly in obese patients.
Moreover, it poses a significant risk of infection with the surgical
site exposed. The situation becomes more complex and difficult
when a three pin traction and the stereotactic frame is being used for
cervical spine surgeries. Laryngoscopy and insertion of a tracheal
tube in the prone position is an equally difficult task.

There are many SADs available in the anesthesiologist’s
armamentarium such as Laryngeal Mask Airway Classic™ (CLMA),
LMA Proseal™ (PLMA), I-gel LMA, and LMA Supreme which are
being used widely for airway management. However, in case of an
emergency situation of accidental extubation in an anesthetized
patient in the prone position, especially in cervical spine surgery;
which SAD would be most appropriate has not been studied.

The aim of our study was to compare three SADs and determine
the most appropriate SAD for securing airway in prone position
during accidental extubation to salvage an emergent situation.
The primary objective of the study was to find which SAD will
take the least time of insertion. The secondary objectives were
to find out which SAD will be easier to insert, provide adequate
ventilation, would give an optimal bronchoscopic view and have
least gastric insufflation of air.

MATERIALS AND METHODS

The study was conducted after approval by the Institute Ethics
Committee. In this study, Airway Trainer Laerdal, Norway
manikin was used for inserting three SADs that is, I-gel
(Intersurgical Ltd., Wokingham, Berkshire, UK), PLMA and
CLMA (Laryngeal Mask Company Limited). A total of 40
anesthesia resident doctors with adequate training (minimum
50 insertions of each device) participated in the study. Prior to
beginning the study, insertion of all available adult sized SADs
were attempted in the manikin by a senior anesthesia consultant,
to determine the correct size of the device to be used. Size no. 4
for all the SADs was found to be the most appropriate and was
selected for conducting the study. Each participant was given
verbal instruction and practical demonstration regarding insertion
of these SADs in the prone position.

Technique of insertion

The manikin was placed in prone position with its head resting
on the horse shoe attachment of operating table, simulating
the position used during cervical spine surgery. Each SAD was
inserted in this position with one assistant placing his hand over
the occiput to keep the manikin stable during SAD insertion
[Figure 1]. All the participants were instructed to stand at the
head end of manikin; hold the device in dominant hand and
open the manikin’s jaw by nondominant hand. I-gel was inserted
by holding it along the bite block portion with the cuff outlet
facing the chin. As the cuff passed the incisors, manikin’s chin
was released, and I-gel was slid into the oral cavity till the end
point of insertion. CLMA was inserted in a similar way with
the technique being slightly different from the conventional
index figure guided approach. Here, the LMA was held-like a
pen in dominant hand, and once the cuff passed the incisors,
index finger was removed and the LMA was inserted. PLMA
was inserted with the help of introducer device. Once the cuff
passed the incisors, manikin’s chin was released and PLMA was
inserted following the curve of the rigid insertion tool.

Each participant inserted all the three SADs into the manikin
placed in prone position in a randomized manner, once. The
sequence of insertion of SAD was randomized using sealed
evelope. An observer who was not involved in the study
recorded all the parameters. Time of insertion of each device
was noted; insertion time was defined as the time from picking
up the SAD till the initiation of ventilation. The resistance
encountered during device insertion, maneuver required in
achieving an acceptable airway, the number of attempts for
successful insertion and failed attempts were recorded. Removal
of the SAD from the mouth of manikin was considered as an
attempt, and more than two attempts at insertion were recorded
as failed attempt. Adequacy of ventilation was determined by
attaching the SAD to anesthesia circuit. Gastric insufflation of
air in the exposed stomach was also recorded. A 3.8 mm fiber
optic bronchoscope (Fujinon, Japan 2012) was introduced
through the SAD and advanced until the best possible view
of vocal cord was obtained. Ease of scope insertion was
graded by the operator as easy (no resistance), fair (if the tip
was manipulated), difficult (>one obstacles). The fiber optic
bronchoscope view of vocal cord was also scored as grade 1:
Vocal cord entirely visible, grade 2: Vocal cord partly visible,
grade 3: Epiglottis only visible, and grade 4: No laryngeal
structure visible. Each insertion was scored (insertion score) by
the observer. A score of 0 indicated worst performance, while
5 was the highest score [Table 1].
Statistical analysis
Based on pilot study, the mean (standard deviation [SD]) time required in PLMA, CLMA, and I-gel LMA insertion was 21.6 (5.6), 13 (2.7), and 10.7 (2.7) seconds, respectively. The difference time taken to insert PLMA and I-gel LMA was 2.3 s. Anticipating 2.3 s difference in each of the pairs, with 1.8% level of significance and 90% power, the estimated sample size was 40 per group. Statistical analysis was carried out using Stata (College Station, Texas, USA). Data were presented as number (%) or mean ± SD as appropriate. The difference in mean of time taken to insert the SAD was compared using Student’s t-test. The ease of insertion and ventilation, bronchoscopy view, ease of bronchoscopy, and insertion score variables were compared among the groups using Chi-square test/Fisher’s exact test. The P < 0.05 was considered as statistically significant.

RESULTS
A total of 40 anesthesia senior residents participated in the study. As shown in Table 2, the time taken for I-gel insertion was least, 12.89 ± 3.94 s as compared to 17.07 ± 3.5 and 25 ± 4.78 s for CLMA and PLMA, respectively, which is statistically significant. Resistance encountered during I-gel insertion was least, while maximum resistance was seen in PLMA group (n = 9; 22.5%) versus (n = 36; 90%). The maneuver was required in 27.5% of PLMA insertion, 2.5% in CLMA while no maneuver was required in any of I-gel insertion (P = 0.001). Reinsertion was required in 3 (7.5%) and in 1 (2.5%) in PLMA and CLMA group, respectively, while no reinsertion was required in I-gel group. There was no failed attempt with any of the three SADs. However, ease of ventilation was comparable in all the three SADs [Table 3]. Ease and view of fiber optic bronchoscopy (FBS) were best with the I-gel group as shown in Table 4. I-gel had the highest insertion score with a mean of 4.7 ± 0.56 as compared to CLMA that is, 4.17 ± 0.71 and PLMA, 3.8 ± 0.72 (P = 0.001) [Table 5].

DISCUSSION
Accidental extubation may occur in an anesthetized patient, being operated in the prone position. Securing the airway in this position presents a great challenge to the anesthesiologist, and may require turning the patient supine emergently. Although direct laryngoscopy, video laryngoscopy, or fiber optic laryngoscopy, and endotracheal tube placement can be attempted with the patient in prone position after inadvertent extubation; the position of the patient is not optimal for these techniques and requires lot of expertise and time to accomplish this task. Various SADs such as CLMA, PLMA, and LMA Supreme have been used successfully for airway management in prone position electively, especially in obese patients.[3-5] However, there are no studies or recommendations in the literature suggesting the most appropriate type of SAD to manage airway emergencies in the prone position. Use of a SAD after inadvertent extubation in the prone position is a useful skill. One could argue that if success is likely in this circumstance, the technique must be used in the elective setting to acquire familiarity and competence.[6]
In this manikin-based study, we found that I-gel provided an acceptable alternative to conventional airway management in the prone position. I-gel insertion took the least time, was easily inserted and adequate ventilation was achieved as compared to CLMA and PLMA.

CLMA has been reported to be inserted for emergency airway management, in patients placed in the prone position. Raphael reported a case of successful management of accidental extubation by inserting a CLMA while the patient was maintained in prone position.\(^\text{[11]}\) The patient was a 12-year-old female undergoing anterior and posterior spinal fusion. In another case report of accidental extubation, CLMA was used as a rescue device in a neonate, who was undergoing surgical repair of meningomyelocele.\(^\text{[7]}\) A similar complication was managed by placing CLMA in a 5-year-old child.\(^\text{[8]}\) All the above case reports emphasized the emergent use of LMA after accidental extubation to secure the airway. All the patients in these case reports were managed successfully. The authors used the SAD with which they were most familiar and perhaps were readily available. No conclusion regarding the most suitable SAD in emergent situation was drawn. None of the case reports mentioned the time taken to insert the CLMA.

Various SADs studied for airway management during elective procedures performed in prone position were placed with the patients already in the prone position. The patients positioned themselves into prone position prior to induction of anesthesia. CLMA was the first SAD to be used for insertion in the prone position. It was successfully used in 73 patients for surgery in the prone position.\(^\text{[9]}\) The authors encountered minor problems related to CLMA insertion; with two incidents of malpositioning, which required repositioning. In this prospective audit, CLMA was inserted by turning the neck slightly to the side; however, in our study, CLMA was inserted in the prone position without any head rotation. The neck was not turned since we were simulating the surgeries being done with the stereotactic frame, where the neck rotation would not be possible. Despite the unconventional position for airway intervention, insertion of CLMA was possible by all the participants with a slight modification of the technique. CLMA showed better result than PLMA but was inferior to I-gel in time of insertion, insertion scoring, and vocal cord view with FBS. In another prospective audit done by López et al., the clinical use of PLMA and LMA Supreme was compared in 120 adult patients in the prone position.\(^\text{[10]}\) The authors observed that both devices can be used, and had no differences in insertion time and first attempt success. However, fewer manipulations were required for PLMA as compared to LMA Supreme (3% vs. 15%; \(P = 0.02\)) to achieve effective ventilation. PLMA also provided higher seal pressure as compared to LMA Supreme. In our study, PLMA results were inferior as compared to CLMA and I-gel. The time taken for PLMA insertion in our study was 25.2 ± 4.78 s as compared to 17 ± 5 s in the above-mentioned audit. The probable reason for this difference may be because in their study while inserting the SAD, head and neck were rotated to one side for airway intervention. In our study, we introduced all SADs in prone position with neutral head and neck position, since we were simulating cervical spine surgery situation. The iron bar used to hold the horse shoe attachment caused obstruction during the insertion of PLMA with introducer unit. This might be the reason for low performance of PLMA in our study. In yet another retrospective audit by Brimacombe et al., the authors described their experience with the PLMA insertion in 245 healthy adults in the prone position for elective procedures.\(^\text{[11]}\) PLMA insertion was successful in all the patients: Eight requiring bougie-guided insertion while 273 insertions were accomplished with digital technique. No comparative study was done by the authors before concluding PLMA as a safe SAD in the prone position.

I-gel is one of the SAD’s frequently used in elective procedures in the supine position. In a prospective multicenter study comprising 2049 I-gel uses (in supine position); it was found that I-gel is a reliable device with success rate of 96% in a broad variety of patients, positions, and modes of ventilation. It provides high airway leak pressure.\(^\text{[12]}\) In another study, I-gel was found to have better FBS view of vocal cords and greater airway seal pressure as compared to CLMA.\(^\text{[13]}\) Even in simulated difficult airway situation, it proved to be a good choice. It gave better FBS view and less epiglottic downfolding though the time taken was more compared to LMA Supreme.\(^\text{[10]}\) However, in all the above studies, the I-gel was inserted in supine position. In a single case report, I-gel was inserted in prone position and effective management of airway was done in a 16-year-old patient operated for flap repair of pilonidal sinus.\(^\text{[11]}\) In our study, results for I-gel insertion

| Table 4: Comparison of bronchoscopic view through the SAD and the ease of bronchoscopy amongst the three groups |
|---|---|---|---|---|---|
| SAD | PLMA (n = 40) | CLMA (n = 40) | I-gel (n = 40) | P |
|Bronchoscopic view through the SAD: n (%)| | | | |
| Grade 1 | 7 (17.5) | 8 (20) | 20 (50) | 0.001* |
| Grade 2 | 29 (72.5) | 32 (80) | 20 (50) | |
| Grade 3 | 3 (7.5) | 0 (0.00) | 0 (0.00) | |
| Grade 4 | 1 (2.5) | 0 (0.00) | 0 (0.00) | |
|Ease of bronchoscopy: n (%)| | | | |
|1 (easy)| 15 (37.5) | 22 (55) | 33 (82.5) | 0.001** |
|2 (fair)| 24 (60) | 17 (42.5) | 7 (17.5) | |
|3 (difficult >1 obstacle)| 1 (2.5) | 1 (2.5) | 0 (0.00) | |

P < 0.005: Significant. SAD: Supraglottic airway device; PLMA: Laryngeal mask airway ProSeal™; CLMA: Laryngeal mask airway classic™; *The difference amongst three groups was significant. Pairwise comparison: Grade 1 vs 2 and PLMA vs I-gel, P<0.005; **The difference amongst three groups was significant. Pairwise comparison: PLMA vs I-gel, P<0.001 and CLMA vs I-gel, P=0.012 (not significant).

| Table 5: Comparison of insertion score amongst three groups |
|---|---|---|---|
| SAD | Mean (SD) | P |
|---|---|---|
| I-gel | | |
| PLMA | 3.8±0.72 | 4.17±0.71 | 4.71±0.56 | 0.001* |

P < 0.005: Significant. SAD: Supraglottic airway device; SD: Standard deviation; PLMA: Laryngeal mask airway ProSeal™; CLMA: Laryngeal mask airway classic™; *The difference amongst three groups was significant.
were better than other devices. The probable reason for this is preformed shape of I-gel which allows easy passage of device in the oral cavity without any maneuver. Moreover, maneuver required for ventilation was less in I-gel and vocal cords were fully visible through I-gel by FBS. An added advantage of using I-gel is that it can be used as a conduit for endotracheal intubation. All these advantages make it superior to other SADs.

Our study is not devoid of limitations. The insertion of an SAD was performed in conditions of tranquility, and the time spent, quality of introduction and effectiveness of ventilation may not be the same during an emergency situation. Being a manikin-based study, the applicability of results in human subjects during an emergency situation is not known; and are likely to differ. However, to perform a clinical study simulating accidental extubation is not possible; hence extrapolating the results of either a manikin-based or a cadaver study in humans is the best option.

CONCLUSION

The results suggest that all three SADs may be inserted successfully in a manikin in the prone position to rescue the airway. However, I-gel was associated with the best insertion score along with least time to insertion as compared to CLMA and PLMA. I-gel would be a useful adjunct finding its place in the airway cart in all surgeries being performed in the prone position.

However, this being a manikin-based study in a simulated scenario done in tranquility; the results may vary and differ in patients during real emergent airway management. Further studies are required in humans to corroborate the above results.

Acknowledgment

We acknowledge Dr. Kalavaini for support and help in statistical analysis.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Raphael J, Rosenthal-Ganon T, Gozal Y. Emergency airway management with a laryngeal mask airway in a patient placed in the prone position. J Clin Anesth 2004;16:560-1.
2. Dingeman RS, Goumnerova LC, Goobie SM. The use of a laryngeal mask airway for emergent airway management in a prone child. Anesth Analg 2005;100:670-1.
3. Ng A, Raitt DG, Smith G. Induction of anesthesia and insertion of a laryngeal mask airway in the prone position for minor surgery. Anesth Analg 2002;94:1194-8.
4. Sharma V, Verghese C, McKenna PJ. Prospective audit on the use of the LMA-Supreme for airway management of adult patients undergoing elective orthopaedic surgery in prone position. Br J Anaesth 2010;105:228-32.
5. López AM, Valero R, Hurtado P, Gambús P, Pons M, Anglada T. Comparison of the LMA Supreme™ with the LMA Proseal™ for airway management in patients anaesthetized in prone position. Br J Anaesth 2011;107:265-71.
6. Ellard I, Wong DT. Should we induce general anesthesia in the prone position? Curr Opin Anaesthesiol 2014;27:635-42.
7. Taxak S, Gopinath A. Laryngeal mask airway classic as a rescue device after accidental extubation in a neonate in prone position. Indian J Anaesth 2011;55:542.
8. Brimacombe JR, Wenzel V, Keller C. The proseal laryngeal mask airway in prone patients: A retrospective audit of 245 patients. Anaesth Intensive Care 2007;35:222-5.
9. Theiler L, Gutzmann M, Kleine-Brueggeney M, Urryler N, Kaempfen B, Greif R. i-gel™ supraglottic airway in clinical practice: A prospective observational multicentre study. Br J Anaesth 2012;109:990-5.
10. Janakiraman C, Chethan DB, Wilkes AR, Stacey MR, Goodwin N. A randomised crossover trial comparing the i-gel supraglottic airway and classic laryngeal mask airway. Anaesthesia 2009;64:674-8.
11. Taxak S, Gopinath A. Insertion of the i-gel™ airway in prone position. Minerva Anestesiol 2010;76:381.