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Short paper

One-rescuer newborn CPR using a face mask or an i-gel supraglottic airway and two-finger compressions – A manikin study with cross-over design

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Abstract

Introduction: When unanticipated neonatal asphyxia occurs, it may be necessary for a single rescuator to commence advanced resuscitation before others arrive. We hypothesised that a single rescuer can provide positive pressure ventilations and chest compressions using higher inflation pressures and better adherence to the recommended compression rate with an i-gel supraglottic airway than with a face mask.

Method: A manikin-based cross-over study was conducted. Twenty-one midwives performed both positive pressure ventilation using a T-piece and chest compressions with the two-finger technique on a newborn manikin alone. They performed ventilation with a face mask or an i-gel. The peak inspiratory pressure (PIP) was set to 30 cmH₂O. The actual PIPs were evaluated based on the values displayed on the manometer. The total amount of time taken to complete 30 cycles of three compressions and one ventilation was also evaluated.

Results: The mean of the average PIP for each participant was significantly lower with a face mask than with an i-gel (17.3 ± 4.4 vs 28.2 ± 2.0 cmH₂O, $p < 0.00001$). The amount of time taken to complete 30 cycles was significantly longer with a face mask than with an i-gel (66.2 ± 6.1 vs 60.6 ± 3.4 seconds, $p < 0.0001$).

Conclusion: During one-rescuer newborn resuscitation using a T-piece and the two-finger technique, the PIPs are consistently high and 30 cycles of CPR are better adhered to 60 seconds using an i-gel.

Keywords: Newborn resuscitation, Lone rescuer, Two finger technique, Supraglottic airway, Face mask

Introduction

Inflation and ventilation of the lungs are the priority in newborn infants who need support immediately after birth. Ventilation with a face mask is a difficult skill to master. In the clinical setting, airway obstruction and face mask leak commonly occur¹. A supraglottic airway is indicated when positive pressure ventilation with a face mask fails. Two clinical trials in late preterm and term infants reported lower rates of the need for endotracheal intubation with the use of a supraglottic airway compared to a face mask (8.5 vs 21.1%² and 0.98% vs 15.85%³).

Chest compressions are rarely needed, but are indicated if the heart rate responds poorly to effective ventilation. If the response to chest compressions is poor, it may be reasonable to provide epinephrine, preferably intravenously. To accomplish advanced resuscitation including vascular access and epinephrine administration, at least three skilled persons are required. However, unanticipated neonatal asphyxia may occur even after an uneventful pregnancy and delivery. It may be necessary for a single rescuator to commence advanced resuscitation before others arrive. The Japanese textbook about neonatal cardiopulmonary resuscitation recommends the two-finger technique over the thumb technique when performing

Abbreviations: PIP, peak inspiratory pressure, ICC, intraclass correlation coefficient

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both ventilation and chest compressions alone⁴. This method has not been evaluated and seems difficult to perform.

We hypothesised that both positive pressure ventilation using consistently high pressures and chest compressions adhering to the recommended time cycle can be accomplished by only one rescuer using an i-gel supraglottic airway.

Methods

We conducted a manikin-based cross-over study in Kitano Hospital from November 19, 2021 to December 6, 2021.

Midwives working in our hospital who were qualified in neonatal cardiopulmonary resuscitation were enrolled. They usually use face mask, and do not use i-gel in clinical practice. They were asked to perform positive pressure ventilation using a T-piece resuscitator (ResusciFlow; Atom Medical, Tokyo, Japan) and chest compressions on a manikin (NewBorn Anne, Laerdal Medical Japan K.K., Tokyo, Japan, Norway) placed on a firm surface with the two-finger technique. The ResusciFlow was set to a gas flow of 10 L/min, a peak inspiratory pressure (PIP) of 30 cmH₂O, and a positive end expiratory pressure of 5 cmH₂O. Each participant performed 30 cycles of three compressions and one ventilation alone using one of the following two ventilation methods (Online supplement).

- face mask: The participant used one hand to hold the manikin's jaw and seal the face mask (IC clamp technique). With the other hand, they performed chest compressions using the two-finger technique and occluded the expiratory valve to produce inspiration alternately.
- i-gel: The participant inserted a size 1 i-gel® (Nihon Koden, Tokyo, Japan) and started ventilation without fixing it with tape. They used one hand to support the i-gel and occlude the expiratory valve with the thumb. They used the other hand exclusively to perform chest compressions.

There was no washout time between the two performances and considering the fatigue and skill improvement after the first 30 cycles (the pace of chest compressions seemed to slow at the end of the performance for some participants), the participants on odd days used face mask first, while on even days i-gel first. Thereafter, we removed the mask and the same participant performed the second 30 cycles with the other method. There was no demonstration of the expected task, but they were advised to observe and obtain adequate chest rises during inspirations. The manometer displays on ResusciFlow were visible to the participants, but they were not informed of the target pressures. The participants were also advised to deliver compressions to a depth of one-third of the anterior-posterior diameter of the chest and perform each cycle at a rate of 2 seconds. They were not provided with verbal feedback about their skills during the performance.

One of the study members (AI or HM) recorded the amount of time taken to complete 30 cycles of chest compressions and ventilations (between the first compression and the last ventilation). The amount of time from grabbing an i-gel to the first chest compression was also recorded. During resuscitation, the manometer displays were recorded with a video (Coolpix A10, Nikon, Japan) at a distance of about 20 cm. The actual PIP values for each ventilation were reviewed afterwards. The participants were not informed of the aim of the study. Normally distributed data are reported as

means ± standard deviations. Data were compared using the paired Student's t-test. Within-participant variability was analyzed using intraclass correlation coefficient (ICC). Two-way repeated measure analysis of variance was used to assess between-subjects variability.

The study was approved by the ethics committee of the Tazuke Kofukai Medical Research Institute (P220200300). Informed consent for data collection was obtained from each participant.

Results

Twenty-one female midwives participated. They had a median of 5 years (range: 1–18 years) of midwifery experience. They had received manikin training including i-gel insertion and chest compression within 6 months. All 21 participants completed the study; 12 started with a face mask and nine started with an i-gel.

A set of 30 ventilations for each method was evaluated (Fig. 1). The mean of the average PIPs for each participant was significantly lower with a face mask than with an i-gel (17.3 ± 4.4 vs 28.2 ± 2.0 cmH₂O, $p < 0.00001$). The spread of the percentage of ventilation PIPs was much wider with a face mask than an i-gel (Fig. 1). ICC was 0.47 (95% confidence interval 0.33–0.66) with a face mask and 0.77 (95% confidence interval 0.66–0.88) with an i-gel, respectively, indicating that within-participant consistency was better with an i-gel. There were significant differences in both between-mask and between-participant analysis. In addition, an interaction effect was present between the two factors (Table 1).

It took 6.0 ± 1.6 seconds (range: 4–10 seconds) to insert an i-gel. The amount of time taken to complete 30 cycles was significantly longer with a face mask than with an i-gel (66.2 ± 6.1 vs 60.6 ± 3.4 seconds, $p < 0.0001$).

Discussion

This study showed that during one-rescuer newborn CPR, insertion of an i-gel resulted in ventilations with consistently high inspiratory pressure and 30 cycles of 3 compressions and 1 ventilation were better adhered to the recommended time of 60 seconds. On the other hand, during ventilation with a face mask, PIPs tended to be inconsistent and cycles of chest compressions and ventilation took longer.

This study asks a potentially clinically relevant question but one that would be difficult to answer in a clinical trial because of the infrequent and unexpected nature of events that lead to performance of chest compressions. A recent study using an animal model of asphyxial cardiac arrest, reported that ventilation using a supraglottic airway with chest compression is feasible and non-inferior to endotracheal tube ventilation⁵. In addition, an animal study indicated that a supraglottic airway prevents pulmonary aspiration of gastric contents during chest compressions⁶. In comparison with endotracheal intubation, a supraglottic airway is much easier to insert without any assistance. Indeed, the time to complete an i-gel insertion was only 6 seconds in this study. We recommend the use of a supraglottic airway before starting chest compressions.

i-gel is a single-use supraglottic airway with a soft, gel-like, non-inflatable cuff that is designed to provide an anatomical fit over the laryngeal inlet. It has several potential advantages over other laryngeal masks including easier insertion (due to the small mask size and no need for cuff adjustment) and good vertical stability (due to the

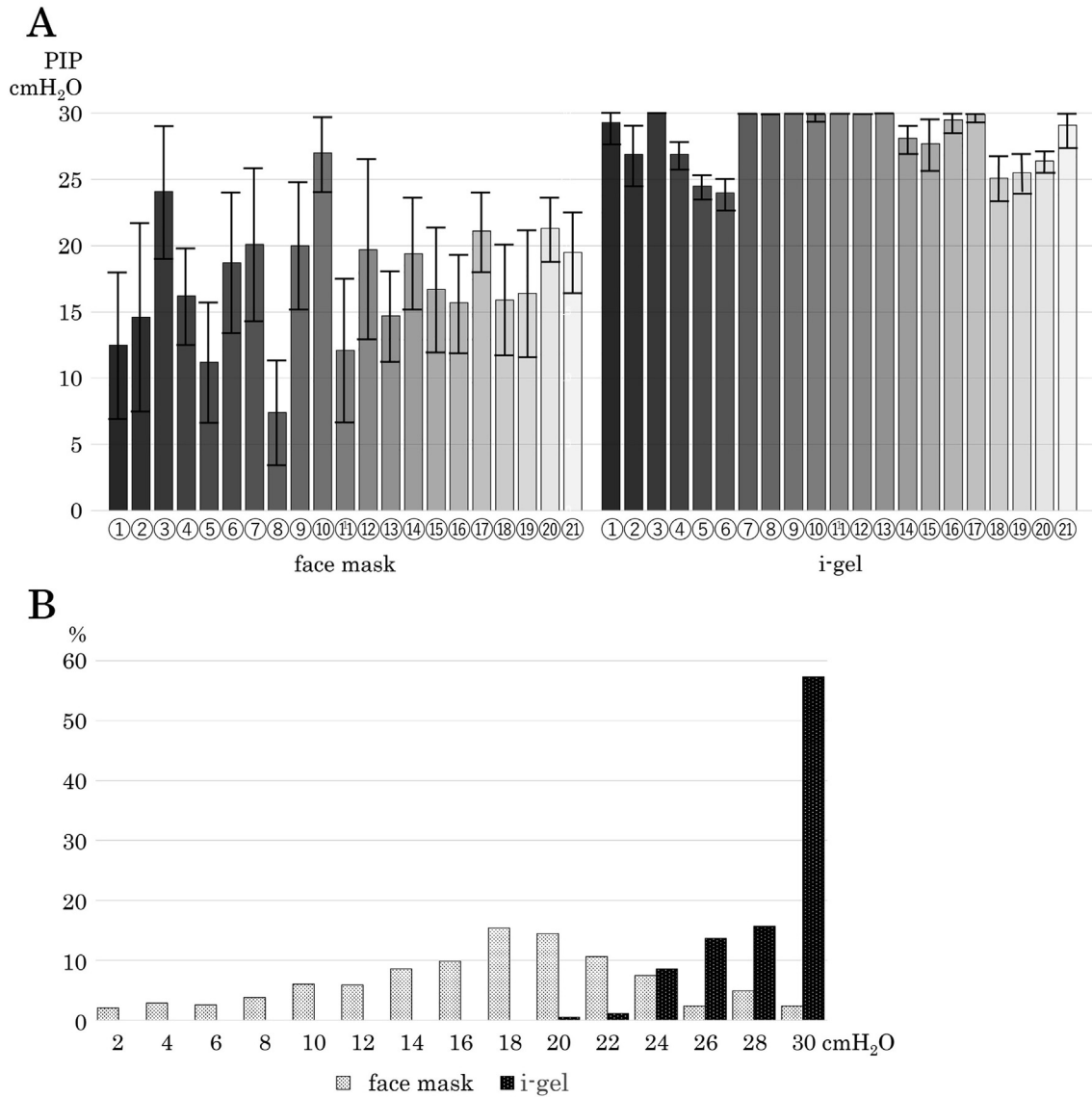


Fig. 1 – A. Bar graph illustrating the mean and standard deviation (error bars) of peak inspiratory pressure (PIP) values of 21 participants with a face mask (left) and an i-gel (right). B. The spread of percentage of ventilation PIPs with a face mask and an i-gel.

Table 1 – Tests of Between-Subjects effects

Source	Sum of Squares	Df	F value	<i>p</i>
(Intercept)	6,53,904	1	55,807.553	<2.2e-16
Mask(face mask or i-gel)	8,455	20	36.078	<2.2e-16
Participant	37,349	1	3,187.55	<2.2e-16
Mask*Participant	6,469	20	27.603	<2.2e-16
Residuals	14,271	1,218		

firmness and wideness of the buccal cavity stabiliser)⁷. In a prior study, all 80 health care workers successfully inserted an i-gel into a neonatal manikin in an average of 5 seconds⁸. In a single-centre, prospective, randomised clinical trial including 49 newborns, positive pressure ventilation using an i-gel reduced the amount of time to spontaneous breathing compared with a face mask⁹.

We believe that our results have potential implications for clinical care. Epinephrine is rarely needed during newborn resuscitation, and the heart rate improves with effective ventilation and compressions in many cases. However, in very rare cases where only two persons are readily available, one can perform both ventilations and chest compressions with an i-gel, while

the other can start obtaining vascular access and administering epinephrine.

A limitation of this study is that we only evaluated two variables, namely, PIPs and the amount of time taken to complete 30 cycles of CPR. During positive pressure ventilation with a T-piece on a manikin model, a low PIP is associated with mask leak¹⁰. An adequate PIP in this study only guarantees mask seal, and ventilation effectiveness should be assessed by other respiratory function measures including tidal volumes. Another possible limitation is that only one type of mask grip (IC clamp) was evaluated. The quality of chest compressions (adequate depth and release) should also be assessed. This is a simulation study using a manikin and its findings may not be replicated in the clinical setting. However, it has been reported that an i-gel is effective in clinical practice after a short training program². The potential benefits must be assessed in a larger trial.

Conclusion

During one-rescuer newborn resuscitation using a T-piece and the two-finger technique, the PIPs are consistently high and 30 cycles of CPR are better adhered to 60 seconds using an i-gel than using a face mask.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.resplu.2022.100276>.

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