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ORIGINAL RESEARCH

Haemodynamic Responses to Insertion of I-Gel® and Endotracheal Tube in Adult Patients Posted for Elective Surgery Under General Anaesthesia by Novices: A prospective Comparative Study

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ABSTRACT

Background: Airway management is a key component of anaesthesia, and airway device choice influences haemodynamic responses. Supraglottic airway devices such as I-gel® are associated with less haemodynamic stimulation than endotracheal intubation. However, prolonged insertion and suboptimal technique in novice practitioners may increase airway stimulation. This study compared haemodynamic responses to I-gel® and endotracheal tube (ETT) insertion by novice trainees.

Materials & Methods: This prospective comparative study included 74 adult patients undergoing elective surgery under general anaesthesia at KS Hegde Hospital over six months. The consultant anaesthesiologist selected the airway device for 37 patients with I-gel® and 37 with an endotracheal tube (ETT), based on the planned airway management technique. Postgraduate (PG) Anaesthesiology students performed airway insertion/intubation under consultant supervision. We recorded heart

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rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure at predefined time points: before induction, after induction, immediately before airway insertion/intubation, during airway insertion/intubation, immediately after airway placement, and at 3, 5, and 15 minutes after airway placement. Secondary outcomes included insertion time and number of attempts.

Results: Haemodynamic responses were broadly comparable between groups. Heart rate and mean arterial pressure increased transiently after insertion and subsequently stabilised. Systolic blood pressure was significantly higher in the I-gel® group at 5 and 15 minutes after insertion ($p<0.05$), while diastolic blood pressure showed no significant difference. ETT insertion took longer. First-attempt success improved significantly with increasing trainee experience ($p=0.001$).

Conclusion: I-gel® and ETT produced broadly comparable haemodynamic responses; however, systolic blood pressure was significantly higher with I-gel® at 5 and 15 minutes after insertion. Increasing trainee experience improved airway management performance, highlighting the importance of structured supervised training.

Keywords: I-gel®, endotracheal tube, haemodynamic response, airway management, novice trainees

INTRODUCTION

Airway management is a fundamental component of general anaesthesia, and the choice of airway device plays an important role in maintaining effective ventilation and haemodynamic stability. Endotracheal intubation (ETT) is widely used for securing the airway during general anaesthesia. However, laryngoscopy and tracheal manipulation can stimulate the sympathetic nervous system, resulting in transient increases in heart rate and blood pressure.[6,7,9]

Supraglottic airway devices (SADs), such as the I-gel®, have been developed as alternatives to endotracheal intubation in selected surgical procedures. The I-gel® is a second-generation supraglottic airway device with a non-inflatable cuff made of thermoplastic elastomer, designed to conform to the perilaryngeal anatomy. Its insertion does not require direct laryngoscopy or tracheal instrumentation.[4,12] Comparative studies have demonstrated differences in haemodynamic responses following I-gel® insertion and endotracheal intubation, with some reporting lower increases in heart rate and mean arterial pressure following I-gel® insertion.[5-7,9,11]

However, the performance of airway devices may be influenced by the experience and skill of the operator. Previous comparative studies have primarily evaluated airway device performance in routine clinical settings, while evidence specifically addressing their use by postgraduate trainees remains limited.[1,2,4,6] Although Wharton et al. evaluated I-gel® insertion by novice operators, including medical students, non-anaesthetist physicians and allied health professionals, their study did not compare I-gel® insertion with endotracheal intubation performed by novice postgraduate trainees.[12] Inexperienced operators may require additional time or repeated attempts to establish an effective airway, potentially increasing airway manipulation and influencing

haemodynamic responses.[12] Therefore, evaluating airway device performance in the hands of novice trainees is clinically relevant.

We hypothesized that although I-gel® insertion may be associated with a reduced haemodynamic response compared with ETT intubation, this advantage may be attenuated when the procedures are performed by novice postgraduate trainees. Therefore, this study aimed to compare the haemodynamic responses following I-gel® insertion and ETT intubation performed by postgraduate trainees in adult patients undergoing elective surgery under general anaesthesia. The secondary objectives were to assess insertion time, number of attempts, time to achieve effective capnography, and the influence of operator experience on airway device performance.

METHODOLOGY

This prospective comparative study was conducted over six months at Justice KS Hegde Charitable Hospital, Nitte (Deemed to be University), Mangaluru, after approval from the Institutional Ethics Committee. The study was prospectively registered with the Clinical Trials Registry–India (CTRI) under registration number CTRI/2024/07/069933 on 04/07/2024. We obtained written informed consent from all participants before inclusion in the study.

Seventy-four adult patients undergoing elective surgery under general anaesthesia were included in the study. The consultant anaesthesiologist selected the airway device based on the planned airway management technique as part of routine clinical practice. Patients were therefore assigned to either the I-gel® or ETT group according to the airway device selected by the consultant anaesthesiologist, and no randomisation was performed. We recruited patients consecutively until we reached the required sample size of 37 participants per group. The sample size was calculated based on the expected change in heart rate, which was considered the primary haemodynamic outcome of the study. Based on a standard deviation of 2.53 in the I-gel® group and 4.84 in the ETT group, an anticipated mean difference of 2.5, an effect size of 0.6784, a two-sided alpha error of 5%, and 80% power, the required sample size was calculated as 37 participants per group, resulting in a total sample size of 74 participants. The calculation was performed by the study statistician using nMaster software, version 2.0. We included patients with ASA physical status I–II, either gender, and Mallampati class I–II, and excluded those with anticipated difficult airway, emergency surgery, obesity (BMI >30 kg/m²), cardiovascular disease, or raised intracranial pressure. All patients were monitored using electrocardiography (ECG), non-invasive blood pressure (NIBP), pulse oximetry (SpO_2), and end-tidal carbon dioxide ($EtCO_2$). Anaesthesia was induced using fentanyl, propofol, and atracurium according to the study protocol. Airway management was performed by anaesthesia postgraduate trainees who had undergone appropriate supervised training in airway management. The I-gel® was inserted without direct laryngoscopy, whereas the ETT was inserted using direct laryngoscopy. Haemodynamic parameters were recorded by the researcher from the standard monitoring equipment, while the trainees were unaware of the specific haemodynamic observations being recorded. The researcher knew the airway device used, so complete blinding was not possible. Heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and SpO_2 were recorded at predefined time points: before induction of anaesthesia, after induction of anaesthesia, immediately before airway

insertion/intubation, during airway insertion/intubation, immediately after successful airway placement, and at 3, 5, and 15 minutes after airway placement. We recorded $EtCO_2$ after establishing effective ventilation. The same haemodynamic parameters were also recorded after removal of the airway device.

Insertion time was defined as the time from commencement of airway device insertion to successful placement and confirmation of effective ventilation. For ETT insertion, we measured the time from laryngoscope insertion to confirmation and fixation of the tube. For I-gel® insertion, the time was measured from commencement of insertion of the device until achievement of a normal capnographic waveform confirming effective ventilation.

We recorded the number of attempts as the number of airway insertion attempts required to achieve successful placement. We defined an attempt as each insertion of the airway device into the patient's airway; withdrawal and reinsertion of the same device was considered a subsequent attempt.

CONSORT DIAGRAM

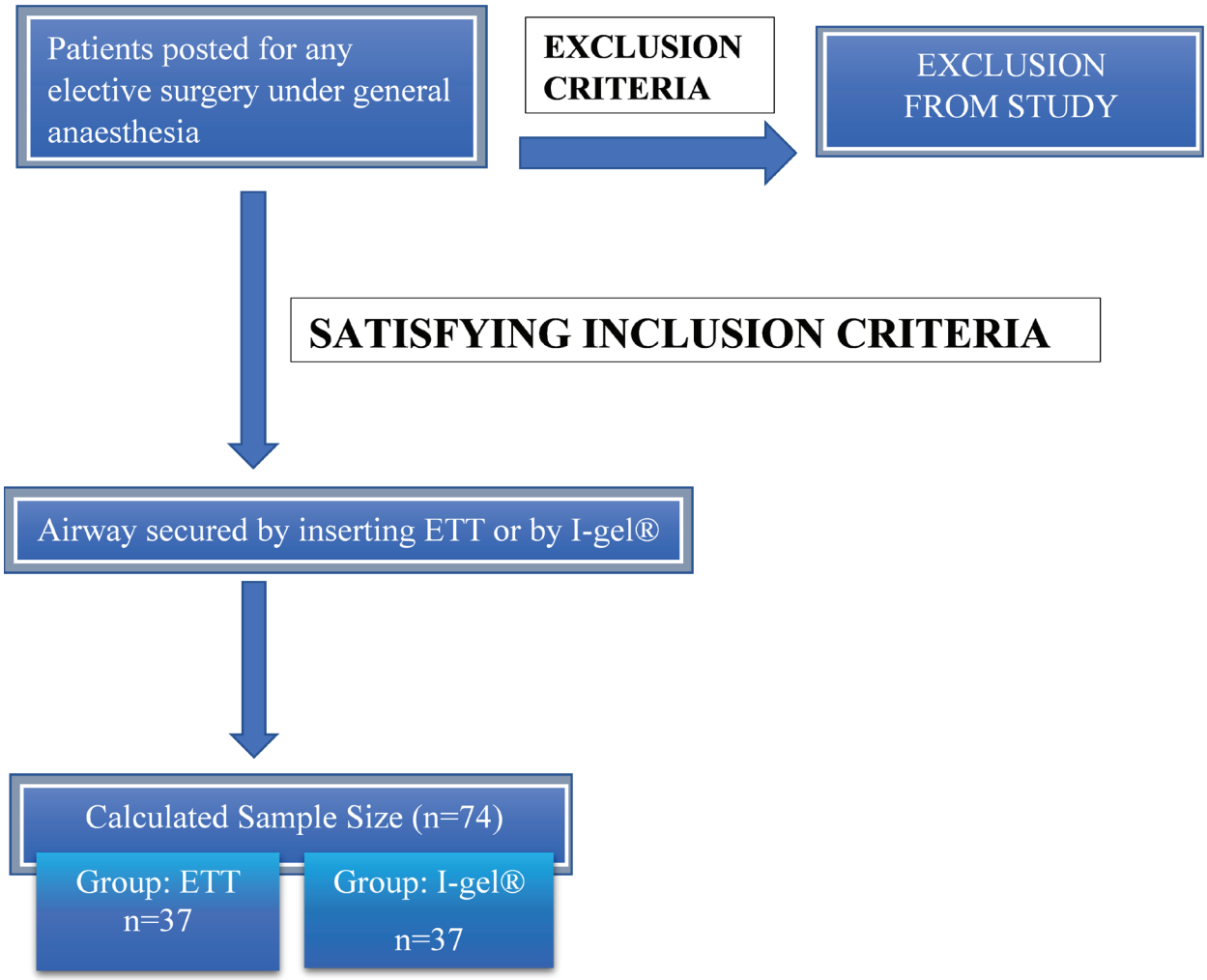


Table 1: Comparison of demographic data of the three groups

		Airway device used				Chi square test	*p*-value
		ETT		I-gel®			
		N	%	N	%		
Gender	Male	20	54.1	8	21.6	8.27	0.004*
	Female	17	45.9	29	78.4		
ASA grade	I	16	43.2	15	40.5	0.06	0.814
	II	21	56.8	22	59.5		
Novice level of training	First year	12	32.4	12	32.4	0	1
	Second year	12	32.4	12	32.4		
	Third year	13	35.1	13	35.1		

Time to achieve effective capnography was defined as the time from commencement of airway device insertion to the appearance of a sustained, normal capnographic waveform indicating successful airway placement and effective ventilation.

Data were recorded using a structured proforma and analysed. Statistical analysis was performed using SPSS version 25.0. Continuous variables were expressed as mean ± standard deviation and analysed using independent t-test or one-way ANOVA where appropriate. Categorical variables were analysed using the chi-square test. A p-value <0.05 was considered statistically significant.

RESULTS

The study included 74 adult patients: 37 in the ETT group and 37 in the I-gel® group. The consultant anaesthesiologist selected the airway device based on the planned airway management technique, and we recruited patients consecutively until we reached the required sample size in each group. We compared baseline demographic characteristics, ASA physical status, and trainee-level distribution between the two groups (Table 1). Gender distribution differed significantly between groups (p=0.004), whereas ASA grade and trainee experience were comparable (Table 1).

Heart rate (HR) was comparable between groups at baseline and after induction of anaesthesia. After airway placement, heart rate increased in both groups, with relatively higher values in the I-gel® group immediately after insertion; however, values gradually returned toward baseline over time. Trends in heart rate according to trainee level are shown in Figure 1.

Systolic blood pressure (SBP) did not differ significantly between groups at baseline or after induction. However, the I-gel® group had significantly higher SBP values at 5 and 15 minutes after airway insertion (p<0.05). Figure 2 illustrates systolic blood pressure trends by trainee level.

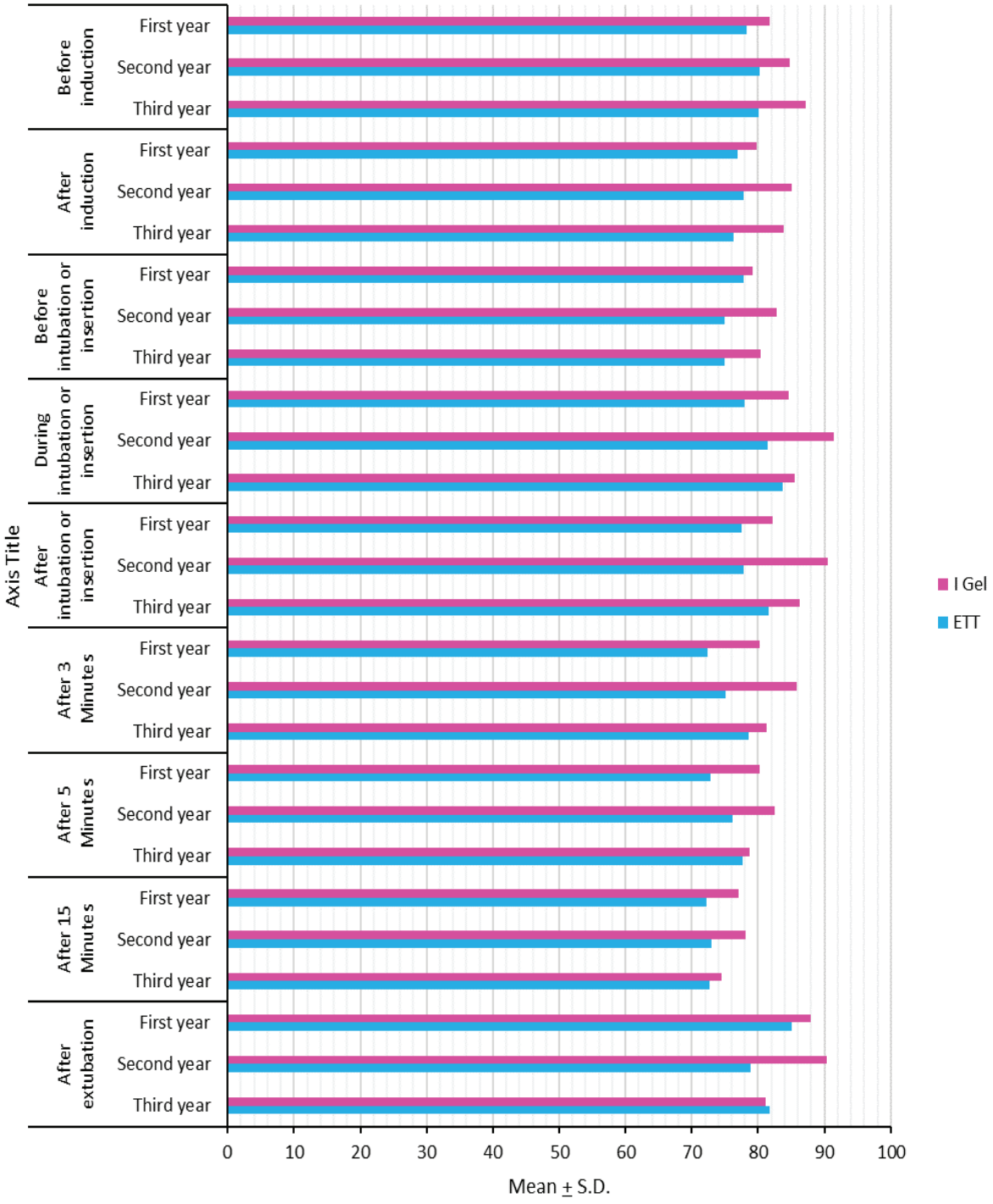


Figure 1: Comparison of HR between the two groups according to novice level of training

Diastolic blood pressure remained comparable between the two groups at all measured time points. Mean arterial pressure (MAP) decreased after induction and increased during airway manipulation in both groups, with slightly higher values observed in the I-gel® group. MAP trends according to trainee level are presented in Figure 3.

Oxygen saturation remained within normal limits throughout the study period in both groups. End-tidal carbon dioxide ($EtCO_2$)

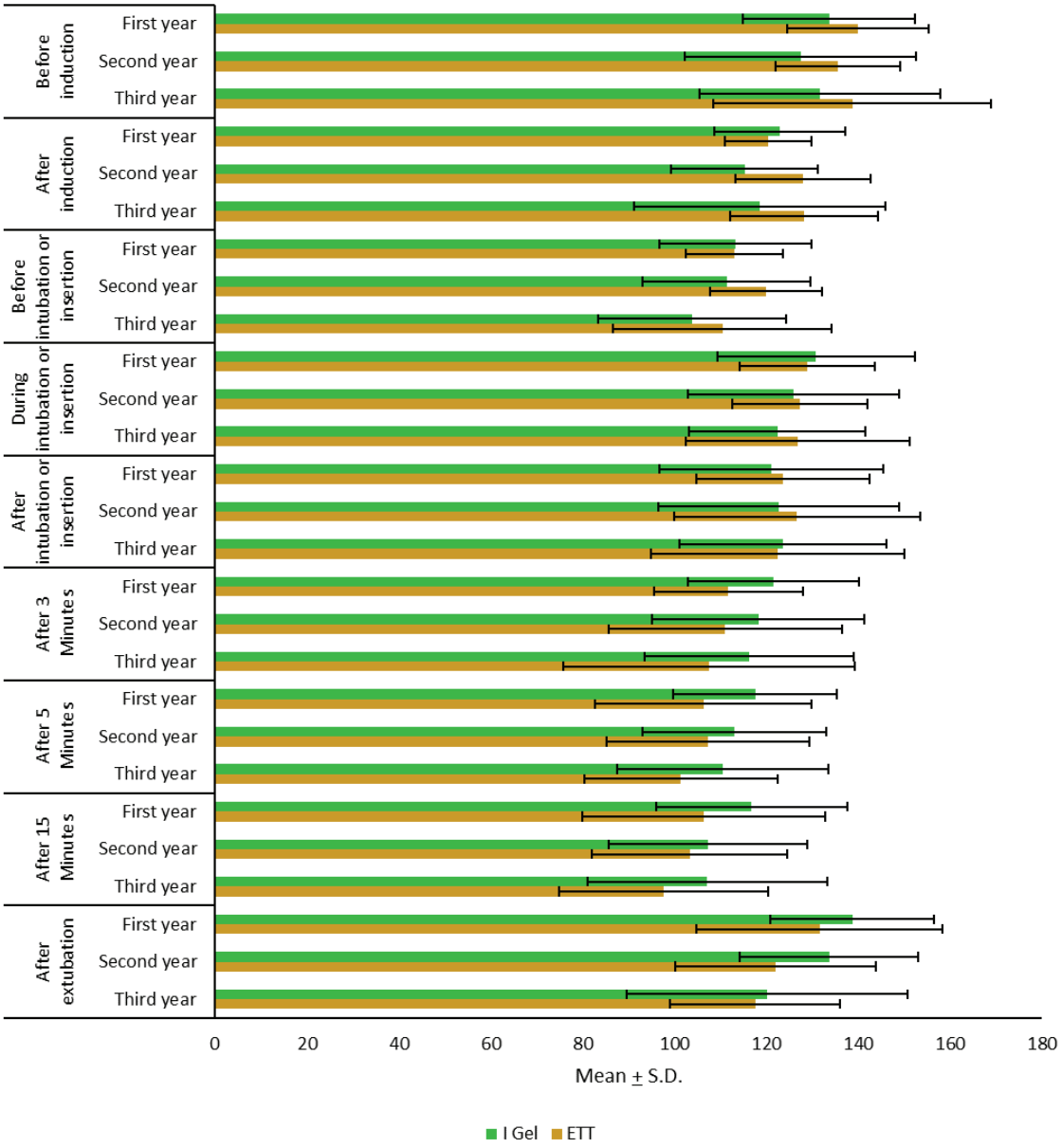


Figure 2: Comparison of SBP between the two groups according to novice level of training.

values were higher in the ETT group during early measurements but became comparable between groups at later time points.

Table 2 compares insertion time and time to achieve effective capnography by trainee level. First-attempt success rates improved significantly with increasing training level (p=0.001). Third-year trainees achieved a 100% first-attempt success rate, whereas first-year trainees required multiple attempts more frequently. Insertion time significantly decreased with increasing trainee experience in both airway device groups. Similarly, time to achieve effective capnography improved with increasing training level.

We used the chi-square test to compare gender, ASA grade, and novice status by airway device used. Gender differed ($p < 0.05$) by airway device used: ETT and I-Gel®.

Table 2: Comparison of time taken for insertion of ETT/ I-gel® and time taken to achieve capnography according to level of training of novices

		ETT			I-gel®		
		Mean±SD	"F"	*p*-value	Mean±SD	"F"	*p*-value
Total time taken for insertion of ETT/ I-gel by novices (seconds)	1st year	101.8±48.6			68.0±17.8	7.68	0.002*
	2nd year	58.1±24.5	10.84	< 0.001*	69.3±29.8		
	3rd year	43.0±16.9			39.4±14.9		
Time taken to achieve capnography (seconds)	1st year	45.2±34.8			33.1±16.0		
	2nd year	36.3±14.8	4.17	0.024*	35.5±10.4	1.54	0.229
	3rd year	20.0±9.1			26.1±14.8		

*("F" = One way ANOVA; * Significant)*

Table 3: Number (%) of attempts required for successful insertion of airway device

	ETT (n=37)	ETT (%)	I-gel® (n=37)	I-gel® (%)
1st attempt successful	33	89.2	28	75.7
2nd attempt required	4	10.8	7	18.9
3rd attempt required	0	0.0	2	5.4

In the ETT group, 33 participants (89.2%) achieved successful insertion on the first attempt, while 4 participants (10.8%) required a second attempt. In the I-gel® group, 28 participants (75.7%) achieved first-attempt success, while 7 (18.9%) required a second attempt and 2 (5.4%) required a third attempt. Thus, the first-attempt success rate was higher with ETT (89.2%) than with I-gel® (75.7%).

DISCUSSION

This study evaluated haemodynamic responses to I-gel® insertion and endotracheal intubation performed by novice anaesthesia trainees, with emphasis on the influence of operator experience. The findings demonstrate that both airway devices are associated with haemodynamic changes; however, procedural efficiency improved significantly with

increasing levels of training, as reflected by reduced insertion time and fewer attempts.

Consistent with previous studies, endotracheal intubation took longer to place successfully than I-gel®. Massoud et al.[11] and Gusain et al.[6] similarly reported faster insertion and fewer attempts with I-gel®. Zuberi et al.[13] also highlighted the advantage of supraglottic airway devices in rapid airway establishment due to the avoidance of laryngoscopy. However, in contrast, our study showed a higher first-attempt success rate with ETT than with I-gel®. This differs from Badheka et al.[10] and Wharton et al.[12], who reported higher success rates with I-gel®, even among novice users. This discrepancy may reflect differences in training familiarity, as trainees may have greater exposure to conventional laryngoscopy than to supraglottic devices.

In terms of haemodynamic responses, I-gel® insertion in the present study was associated with a transient increase in heart rate and mean arterial pressure immediately after insertion, which subsequently normalised. Although supraglottic airway devices are generally associated with reduced sympathetic stimulation, our findings suggest that this advantage may be attenuated in novice operators. Prolonged insertion time and multiple attempts may increase airway stimulation, thereby influencing haemodynamic responses. Similar findings were reported by Badheka et al.[10] and Adhikari et al.[5], where both devices showed initial increases in haemodynamic parameters followed by stabilisation.

Contrary to our findings, Biswas et al.[9] demonstrated significantly greater haemodynamic responses and stress hormone elevation with ETT compared to I-gel®. Akhondzadeh et al.[7] and Saiyed et al.[8] reported similar observations, where laryngoscopic intubation produced more pronounced sympathetic stimulation. The difference may be explained by the involvement of experienced operators in those studies, whereas the present study focused on novice trainees, highlighting the role of operator skill in influencing haemodynamic outcomes.

Systolic blood pressure trends were comparable between the groups initially, although higher values were observed in the I-gel® group at later time points. Diastolic blood pressure remained stable, suggesting minimal variation in vascular tone. These findings are consistent with previous studies demonstrating comparable haemodynamic stability between supraglottic airway devices and endotracheal intubation under controlled conditions.[1,2,4]

Importantly, this study highlights the significant impact of novice experience on airway management. First-attempt success rates improved progressively with increasing training experience, reaching 100% among third-year trainees. The progressive reduction in insertion time with increasing trainee experience further suggests improvement in technical proficiency and airway management skills. Similar observations regarding novice I-gel® insertion have been reported by Wharton et al.[12]

Overall, the haemodynamic responses to I-gel® and ETT were largely similar; however, SBP was significantly higher in the I-gel® group at 5 and 15 minutes after airway insertion ($p<0.05$). Thus, the findings do not indicate complete equivalence of haemodynamic responses at all time points. Although I-gel® is theoretically associated with reduced haemodynamic disturbance, this advantage may not be consistently observed

when the device is used by novices. These findings emphasise the importance of structured training and supervised practice to ensure safe and effective airway management.

CONCLUSION

The study has certain limitations. The relatively small sample size may limit the generalisability of the findings. The study included only ASA I and II patients, which may not reflect outcomes in higher-risk populations. Additionally, the consultant anaesthesiologist's non-random selection of the airway device resulted in an imbalance in gender distribution between the groups, with a higher proportion of males in the ETT group and females in the I-gel® group. Since gender may influence airway anatomy and haemodynamic responses to airway manipulation, this imbalance represents a potential confounding factor and may have influenced the observed haemodynamic outcomes. Additionally, haemodynamic parameters were the primary focus, and other clinically relevant outcomes such as postoperative complications, airway trauma, and patient comfort were not assessed. A multicentric randomized study with a larger sample size, balanced baseline characteristics, and inclusion of both novice and experienced practitioners would provide a more comprehensive understanding of airway device performance.

LIMITATIONS

The study has certain limitations. The relatively small sample size may limit the generalisability of the findings. The study included only ASA I and II patients, which may not reflect outcomes in higher-risk populations. Additionally, haemodynamic parameters were the primary focus, and other clinically relevant outcomes such as postoperative complications, airway trauma, and patient comfort were not assessed. The depth of anaesthesia and the interval between induction and airway instrumentation were not objectively standardized or prospectively recorded, which may have contributed to variations in haemodynamic responses. A multicentric study involving a larger sample size, standardized anaesthetic depth and timing of airway instrumentation, and inclusion of both novice and experienced practitioners would provide a more comprehensive understanding of airway device performance.

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AUTHORS' CONTRIBUTIONS

Conceptualization and design: MM, AB

Literature search: MM

Data collection: MM

Data analysis: MM, AB

Manuscript drafting and critical revision: MM, AB

Proofreading and approval of the manuscript: MM, AB

FUNDING

No external funding was received to prepare the manuscript.

DECLARATION OF CONFLICTS OF INTEREST

There are no conflicts of interest to declare.

ETHICAL CLEARANCE

Approved by the Institutional Ethics Committee of the KS Hegde Medical Academy, Nitte University, Mangaluru, Karnataka, India (No: INST.EC/EC/007/2023); Approval date: March 11, 2023.

The study was registered with the Clinical Trials Registry – India.

(CTRI No: CTRI/2024/07/069933)

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