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ORIGINAL RESEARCH ARTICLE

HEMODYNAMIC RESPONSES BETWEEN I-GEL AND ENDOTRACHEAL TUBE IN PATIENTS UNDERGOING LAPAROSCOPIC SURGERIES

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ABSTRACT

Background: Laparoscopic surgeries are commonly performed under general anesthesia using endotracheal intubation. Laryngoscopy and endotracheal intubation cause exaggerated hemodynamic response which may be detrimental to hypertensive patients and those with cardiac issues. I-gel, a second generation supraglottic airway device mitigates this effect and can be safely used under general anesthesia.

Methods: This was a prospective comparative study consisting of 64 patients undergoing laparoscopic surgery. The patients were divided into endotracheal tube group and I-gel group, each group with 32 patients, which was done according to convenience sampling method. Patient's baseline heart rate, systolic, diastolic and mean arterial blood pressure was recorded. These parameters were recorded at one, three and five minutes of placement of airway device, after creating caboperitonium and after extubation which were compared statistically.

Results: Exaggerated hemodynamic response was observed in endotracheal tube group after endotracheal intubation and immediately after extubation as compared to I-gel group which were more stable. However, both the group had similar hemodynamic response during carboperitonium.

Conclusions: I-gel can be safely used in laparoscopic surgeries under general anesthesia and also lessens the hemodynamic response as compared to endotracheal tube during laryngoscopy and intubation.

INTRODUCTION

Laparoscopic surgeries are gaining popularity as being less invasive, reduced postoperative pain and have a benefit of early hospital discharge.[1] Endotracheal tube is commonly used to protect the airway during general anesthesia. I-gel, a second generation supraglottic airway device has an anatomical seal of the pharyngeal, laryngeal and perilaryngeal structures. It can be used in spontaneously breathing patient or while they are being delivered intermittent positive pressure ventilation (IPPV).[2]

Laryngoscopy and tracheal intubation not only increases sympathetic response but also increases sympathoadrenal activity, which acts as a physiological link between the sympathetic nervous system and the adrenal medulla. This determines the physiological response of an individual to the external stimuli. Release of trophic hormones from hypothalamus stimulates release of adrenocorticotropic hormone, thyroid stimulating hormone, growth hormone, follicle stimulation hormone, luteinizing hormone and prolactin along with anti-diuretic hormone from pituitary gland.[3] Afferent impulses are carried through trigeminal, glossopharyngeal, vagus and sympathetic nerves from the airway which are relayed in cranial nerve nuclei, vasomotor and autonomic regulatory area.[4] Endotracheal intubation causes increase in hemodynamic responses that cannot be completely attenuated by opioids or inhalation agents while I-gel can be safely used to protect airway even with positive pressure ventilation.[5,6] Supraglottic airway device causes less hemodynamic stress response, increased case turnover and decreases the incidence of sore throat.[7]

The objective of this study was to assess the hemodynamic response with the endotracheal tube (ET tube) during intubation and while inserting the I-gel, while creating carboperitoneum and during extubation in patient undergoing laparoscopic surgery.

METHODS

This was a prospective comparative study in patients undergoing laparoscopic surgeries (cholecystectomy, appendectomy, hernioplasty) in College of Medical Sciences (COMS) from July

1st 2020 until the desired number of sample size was achieved, after approval from institutional review committee (COMSTH-IRC ref. no. 2020-053). Written and verbal informed consent were taken from the patients.

All patients aged between 20-65 years of both gender belonging to ASA I and II undergoing elective laparoscopic surgery were included in this study and those patient with BMI>30 or requiring emergency surgery and those who did not give consent were excluded from the study. Sample size calculation was done with reference to previous study.[8] (using the following formula)

$n= (Z_{\alpha/2} + Z_{\beta)}^{2} * 2 * \sigma^2/d^2)$

Where, $Z_{\alpha/2}$ is the critical value of Normal distribution at $_{\alpha/2}$ for the confidence level of 95%, α is 0.05 and the critical value is 1.96.

Z_{β} is the critical value of the normal distribution at β (For a power of 80%, β is 0.2 and the critical value is 0.84)

σ^2 is the population variance and d is the difference we like to detect.

We expected to detect a difference of at least 14mmHg (the standard deviation of the two groups is 20mmHg, that is, the variance is 400)

$n= (Z_{\alpha/2} + Z_{\beta)}^{2} * 2 * \sigma^2/d^2$
$= (1.96+0.84)^2*2*400/ (14)^2$
$= (2.8)^2*2*400/196$
$=7.84*2*2.04$
$=32$

Therefore, in order to detect a difference of this magnitude, that is, significant with 95% confidence and a power of 80%, we require 32 patients in each group.

After careful patient evaluation and airway assessment, patient was premedicated with ranitidine 150 mg and metoclopramide 10 mg per oral, the evening before and the morning of the day of surgery. After verifying the patient, an intravenous cannulation was done, routine monitors were applied and baseline heart rate, systolic, diastolic and mean arterial blood pressure were recorded. Anesthesia was induced with midazolam 0.04mg/kg, propofol 2mg/kg, fentanyl 2mcg/kg and airway placement were facilitated by vecuronium 0.1mg/kg.

Decision of allocation of the first patient was done according to convenience of the researcher followed by which the alternate airway device was used in subsequent patient. All the patients who fulfilled the inclusion criteria were included in the study. The airway placement was done by consultant anesthesiologist.

Tracheal tube of size 7.0 mm and 7.5 mm (internal diameter) were used for female and male respectively, while I-gel of number 4 was used for both female and male for securing the airway. Maintenance of anesthesia was done with 2% isoflurane, 50% oxygen in air and intermittent positive pressure ventilation.

Surgical incision was requested five minutes after induction and airway insertion to avoid likely stimuli. Serial heart rate, systolic, diastolic and mean arterial blood pressure was recorded as the baseline just before induction and at one, three and five minutes after airway device placement, after carboperitoneum and after extubation. All patients were ventilated with 6-8ml per kg of tidal volume to maintain end tidal carbon dioxide in the range of 30-40 mmHg. During carboperitoneum, the intra-abdominal pressure was maintained between 12-14mmHg. Any dislodgement of I-gel and not delivering set tidal volume and those failing to seal the airway properly were replaced by endotracheal tube and were recorded. After surgery, neuromuscular blockade was reversed with neostigmine 0.04mg/kg and glycopyrrolate 0.01mg/kg.

Statistical package for social sciences (SPSS) version 20 was used for statistical analysis. The continuous data (age, heart rate, systolic, diastolic, mean arterial pressure) were analyzed. The value of $p<0.05$ was considered statistically significant.

RESULTS

The demographic data of the patient revealed that there was no statistically difference between ET tube group and I-gel group regarding age (p value 0.19), gender (p value 0.77) and American society of anesthesiologists (ASA) physical status (p value 0.61) (Table 1).

Table 1: Demographic characteristics

Variables	ET tube (n=32)	I-gel (n=32)	p value
Age (years)	35.6±9.81	33.0±5.58	0.19
Gender			
Male	8 (25%)	7 (21.88%)	0.77
Female	24 (75%)	25 (78.12%)	
ASA physical status			
I	18 (56.25%)	20 (62.5%)	0.61
II	14 (43.75%)	12 (37.5%)	

ASA: American Society of Anesthesiologists, n= number, p value <0.05 is considered statistically significant

The baseline hemodynamic parameters like heart rate (p value 0.51), systolic blood pressure (p value 0.10), diastolic blood pressure (p value 0.45) and mean arterial pressure (p value 0.06) were comparable between two groups. There was significant increase in hemodynamic response in the ET tube group up to 5 minutes after endotracheal intubation (p value <0.001) while there was decrease in heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure in I-gel group (table 2). There was significant difference between the two groups in systolic blood pressure, diastolic blood pressure and the mean arterial pressure (p value <0.001, 0.04 and 0.01 respectively) at one minute of after extubation, however, there was no significant difference in heart rate in

one minute (p value 0.36). Similarly, there were no statistically difference in hemodynamic parameters between two groups at three and five minutes of after extubation (p value >0.05) as shown in table 2.

Table 2: Hemodynamic parameters (heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure) of baseline, after intubation and extubation

Variables		Baseline	After intubation			After extubation		
Mean ±SD			1 min	3 min	5 min	1 min	3 min	5 min
HR (bpm)	1	84.7±16.2	97.5±10.7	95.9±12.5	87.0±11.2	107.5±12.7	99.1±16.1	93.8±12.5
	2	82.2±13.9	77.6±10.7	77.0±9.9	74.0±9.2	104.7±11.8	98.5±12.6	92.4±16.1
p value		0.51	<0.001	<0.001	<0.001	0.36	0.87	0.69
SBP (mmHg)	1	129.4±9.9	138.0±23.5	122.7±21.1	115.9±13.4	143.4±13.7	134.6±15.1	130.8±17.7
	2	125.2±10.5	111.3±14.3	99.1±11.9	103.4±10.8	129.3±11.2	133.9±17.4	131.4±10.7
p value		0.10	<0.001	<0.001	<0.001	<0.001	0.86	0.87
DBP(mmHg)	1	77.5±9.1	85.5±15.6	76.3±16.2	72.0±9.1	89.0±12.1	84.9±12.2	82.2±11.4
	2	76.1±5.2	68.4±9.4	60.3±15.0	63.2±10.5	82.5±13.6	85.9±12.1	84.7±8.9
p value		0.45	<0.001	<0.001	<0.001	0.04	0.74	0.33
MAP (mmHg)	1	91.0±9.1	99.2±17.0	87.8±16.5	82.3±9.9	103.1±13.1	96.5±12.4	94.9±13.1
	2	87.0±7.6	78.2±9.9	69.5±13.2	72.9±11.0	93.6±14.0	97.9±11.3	96.3±8.1
p value		0.06	<0.001	<0.001	<0.001	0.01	0.06	0.60

1: ET tube group, 2: I-gel group, SD: standard deviation, HR: heart rate, bpm: beats per minute, SBP: systolic blood pressure, DBP: diastolic blood pressure, MAP: mean arterial pressure, p value <0.05 is considered as statistically significant

At one minute of after carboperitoneum, there was significant difference in heart rate between two groups (p value 0.02) but there was no difference in systolic blood pressure (p value 0.17), diastolic blood pressure (p value 0.15) and mean arterial pressure (p value 0.36) as shown in table 3.

Table 3: Hemodynamic parameters (heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure) after carboperitoneum

Variables		After carboperitoneum		
Mean ±SD		1 min	3 min	5 min
HR (bpm)	1	92.6±10.8	95.4±15.0	90.3±16.0
	2	85.1±14.2	93.5±11.1	87.2±15.5
p value		0.02	0.56	0.43
SBP (mmHg)	1	133.1±23.0	139.6±21.8	140.5±19.8
	2	127.0±9.5	135.3±12.7	131.3±12.1
p value		0.17	0.33	0.03
DBP (mmHg)	1	88.9±9.0	92.8±14.3	95.8±15.5
	2	84.9±12.9	92.6±10.4	87.6±12.6
p value		0.15	0.94	0.02
MAP (mmHg)	1	98.8±17.6	104.0±15.4	105.9±15.8
	2	95.3±13.0	101.5±9.5	97.7±12.0
p value		0.36	0.43	0.02

1: ET tube group, 2: I-gel group, SD: standard deviation, HR: heart rate, bpm: beats per minute, SBP: systolic blood pressure, DBP: diastolic blood pressure, MAP: mean arterial pressure, p value <0.05 is considered as statistically significant

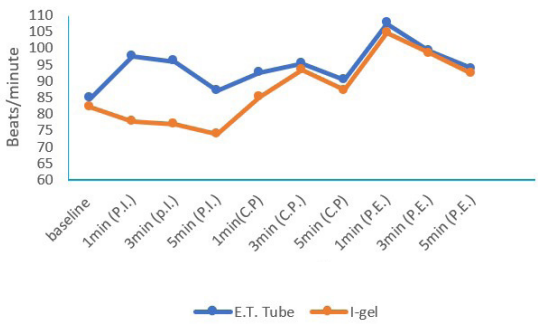

Figure 1: Comparison of heart rate
P.I: post intubation, C.P: carboperitoneum, P.E: post extubation

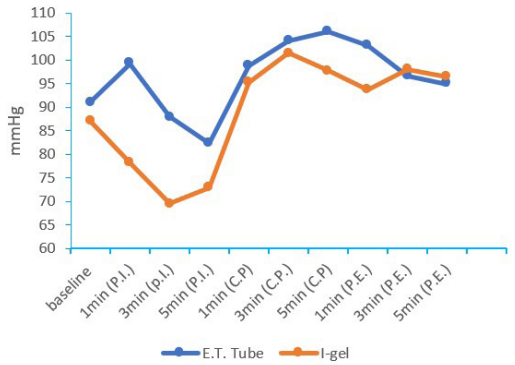

Figure 2: Comparison of mean arterial pressure
P.I: post intubation, C.P: carboperitoneum, P.E: post extubation

DISCUSSION

This was a prospective, comparative study where ET tube and I-gel were used to secure the airway during laparoscopic surgery under general anesthesia. Endotracheal intubation is considered as a gold standard for securing airway during general anesthesia.[9] However, laryngoscopy and intubation

with ET tube also stimulates hemodynamic response by stimulating numerous sensory receptors present in lower pharynx, epiglottis and larynx.[10] This stress response causes increase in catecholamine and cortisol level in plasma. The technique and the duration of laryngoscopy and intubation has a proportional effect in raising these stress hormones. This increase in the sympathetic activity causes increase in heart rate, blood pressure and may lead to arrhythmia.[11] The use of I-gel, a second generation supraglottic airway device, may mitigate the unwanted effects of endotracheal intubation.[12,13] In a study done by Badheka JP, the researchers concluded that I-gel can be used safely to provide mechanical ventilation during positive pressure ventilation in laparoscopic surgery and can be considered as an alternative to endotracheal intubation.[14]
In this study, the heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure increased after ET tube placement, and remained elevated for 5 minutes post intubation when compared to baseline values. However, these parameters were decreased below the baseline value in I-gel group, which may be due to the stimulation of vagal fibers while inserting the I-gel. In a study done by Fujii Y, the hemodynamic response increased after endotracheal intubation with ET tube, which was similar to our study.[15] However, in contrast to their study, we found the hemodynamic parameters decreased from the baseline value after insertion of I-gel. This can be explained by the use of injection atropine of 0.5mg intramuscularly, 30 minutes prior to induction in that study. The induction agent used in that study was thiopentone, which is known to cause reflex tachycardia. In our study, atropine was not used to premedicate the patient and propofol was used as an induction agent, which reduces arterial blood pressure and heart rate. This study found that using either ET tube or I-gel did not have significant difference in hemodynamic parameters while creating a carboperitoneum, which is supported by the study done by Hypolito O. et al., where they concluded that high and transient increase in intra-abdominal pressure created by carboperitonium increases mean arterial pressure, pH, bicarbonate (HCO_3) level and base excess (BE), although these changes were not of clinical importance.[16]

In this study, after one minute of extubation, the heart rate increased in both the groups which was statistically insignificant (p value 0.36) but the changes in systolic (p value <0.001), diastolic (p value 0.04) and mean arterial pressure (p value 0.01) were significant between ET tube and I-gel group. This result was similar to the study done by Fujii Y, where they concluded that the removal of LMA was associated with decrease in hemodynamic response as compared to tracheal extubation in either hypertensive or normotensive patients.[17] However, after three minutes and five minutes of extubation, there was no significant difference in either group (p value >0.05). This result was found to be similar to the study done by Maharjan SK, which was a comparative study done to compare the hemodynamic and ventilator responses between I-gel, laryngeal mask airway and tracheal intubation during laparoscopic cholecystectomy.[18]

The present study was done to compare the hemodynamic parameters between the two groups but the stress markers like cortisol and catecholamines assay was not done, without which a definitive conclusion cannot be made. In this study, after securing the airway with I-gel, no I-gel were removed and replaced with ET tube to secure the airway. Adequate ventilation and oxygenation were achieved in both the groups. There was no leak noted in I-gel group, which was confirmed by auscultation of adequate air entry in bilateral lung fields, listening of gurgling sound, oxygen saturation (SpO_2) and capnography, however, the leak fraction would have been the better technique to determine the leakage in each group.

CONCLUSION

Those patients who are hypertensive and have difficult airway, I-gel can be used to secure airway during the general anesthesia as it provides less hemodynamic instability and can safely deliver oxygenation and ventilation but with a proper monitoring of the patient.

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CONFLICT OF INTEREST: None

FINANCIAL DISCLOSURE: None

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