Prospective randomized double blind study for determining the efficacy of Sellick’s maneuver for preventing gastric distension during mask ventilation

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**ABSTRACT**
Sellick’s maneuver is a technique in which pressure is applied over the cricoid cartilage to occlude the upper part of esophagus which passes behind it. It is used to prevent regurgitation of gastric and esophageal contents and gastric distension during intubation and mask ventilation. This research is conducted to determine the efficacy of Sellick’s maneuver in preventing gastric distension during mask ventilation using ultrasound. Sixty patients posted for elective surgery were selected and randomly allocated to a group receiving Sellick’s Maneuver (SM) or No Sellick’s Maneuver (NSM). Patients of both groups had their gastric antral cross sectional area (CSA) measured using ultrasound before induction of anesthesia and after intubation and mask ventilation. The SM group was intubated after application of Sellick’s maneuver. Gastric volume was then calculated from the gastric antral CSA. Changes in gastric volume among SM and NSM group were assessed to determine whether Sellick’s maneuver is effective in preventing gastric distension. Changes in gastric antral CSA and gastric volume before anesthesia induction and post-intubation is lower in the SM group as compared to the NSM group. Sellick’s Maneuver is effective in preventing gastric distension.

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For proper application of the maneuver it must be ensured that the pressure is applied directly to the cricoid cartilage only, the pressure is applied correctly in the backward direction, the correct amount of pressure is applied, that is, up to 10 N in a conscious patient and up to 30 N in an unconscious patient, the pressure should be applied adequately for appropriate duration and must not be released prematurely for successful application of Sellick’s maneuver (Sellick, 1961).

INTRODUCTION
Sellick’s Maneuver or Cricoid pressure is occlusion of the upper part of the esophagus by application of a backward pressure on the cricoid cartilage ring against the bodies of the cervical vertebrae to prevent gastric and esophageal contents from regurgitating and reaching the pharynx (Sellick, 1961).

According to Sellick et al., to perform the Sellick’s maneuver correctly –the cricoid cartilage is palpated carefully and then lightly held between the thumb and the index finger; after the patient is induced with an anesthetic agent, the pressure is exerted on the cricoid cartilage ring mainly by the index finger. A conscious patient can tolerate an only moderate amount of pressure without discomfort, but after the patient loses consciousness, firm pressure is applied. The pressure is maintained till endotracheal tube intubation and the endotracheal cuff inflated, then the pressure on the cricoid cartilage is released (Sellick, 1961).

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The Sellick’s maneuver was proposed by BA Sellick to reduce the incidence of regurgitation of contents of the stomach and esophagus. During induction of anesthesia, protective airway reflex is lost, and there is a decrease in the tone of the lower esophageal sphincter and raised intragastric pressure. It results in a higher incidence of regurgitation of gastric and esophageal contents to the pharynx, which can then be aspirated into trachea or lungs, causing aspiration pneumonitis (Loganathan and Liu, 2012; Morgan et al., 2006). It was theorized that it could be prevented by the application of Sellick’s maneuver as occlusion of upper end of esophagus prevents the contents of regurgitation from reaching to the pharynx.

The Sellick’s Maneuver is widely used in Rapid Sequence Induction and Intubation (RSII). The RSII includes sufficient pre-oxygenation, administration of an induction agent like propofol and fentanyl and depolarizing neuromuscular blocker like atracurium, application of Sellick’s maneuver, laryngoscopy visualization and intubation with an endotracheal tube (Hagberg and Artime, 2015; Stept and SAFAR, 1970).

Face mask ventilation (FMV) is usually avoided before intubation because there is an increased risk of gastric insufflation, but sometimes it leads to increased risk of patients undergoing hypoxemia if there is an intubation failure or patients suffering from conditions of low functional residual capacity like obesity or COPD (Hagberg and Artime, 2015; Clements et al., 2009; Brown and Werrett, 2009). Furthermore, high airway pressure during mask ventilation can lead to insufflation of gas into the stomach causing gastric distension which in turn increases the risk of regurgitation and aspiration (Ruben et al., 1961).

The purpose of this study is to determine if the Sellick’s maneuver is effective in preventing gastric distension by assessing the changes in the gastric antral cross sectional area (CSA) using ultrasound and calculating gastric volume (GV) before induction and after the intubation and face mask ventilation (FMV). The appearance of comet tail artifacts also indicates excessive insufflation of gas into the stomach causing gastric distension (Bouvet et al., 2014; Garrido et al., 2013).

**METHODOLOGY**

The study was started after obtaining approval from the Institutional Ethics Committee (IEC) and obtaining written informed consent form from the patients. Sixty patients who were posted for elective surgery under general anesthesia were studied.

All the patients were of ASA classification class 1 or 2. Patients with hiatus hernia, esophagitis, gastroesophageal reflux, disorders of esophageal or gastric motility, inadequate fasting, anticipated difficult ventilation (beard), pregnant woman, thyroid swelling, pre-operative nasogastric tube in-situ were excluded.

The sixty patients were randomized to receive Sellick’s Maneuver (Group SM) or No Sellick’s Maneuver (Group NSM) using a randomization table. The patients were shifted to the operation theatre on the morning of the study and the time since their last oral intake of solids and liquids was noted to ensure fasting status, at least 8 hours for foods and 3 hours for liquids. An intravenous line was secured, and appropriate crystalloid started. Standard monitors were connected including the ECG, NIBP, SpO2 and Etco2.

Using ultrasound the baseline gastric antral cross sectional area (CSA) was measured in the supine position and right lateral decubitus position by a blinded person who then left the O.T. and was thus blinded to which group the patient belonged to.

Both groups underwent routine induction of General Anesthesia with an appropriate dose of propofol (2mg/kg), fentanyl (2mcg/kg) and atracurium (0.4mg/kg) and masked ventilated for 3 minutes. The group SM underwent mask ventilation with Sellick’s maneuver after explaining to them that they would feel pressure on their cricoid area while the group NSM did not. Both groups were then intubated using direct laryngoscopy with an appropriate sized endotracheal tube. The position of the tube was confirmed with an End-tidal carbon dioxide tracing on the monitor. In the study group (SM), the cricoid pressure was released. Using ultrasound, the appearance of comet tail artifacts, if any, were noted as it indicates insufflation of gas into the stomach and gastric distension.

The blinded person was then admitted to the operation theatre after intubation and the gastric antral CSA was measured again in the supine position and right lateral decubitus position (RLDP) using ultrasound. Gastric volume (GV) in the supine position and right lateral decubitus positions (RLDP) was calculated from gastric antral CSA using the formula described by Perlas et al. (2013):

\[
GV (ml) = 27.0 + 14.6 \times right\ lateral\ CSA - 1.2 \times age
\]

**Statistical Analysis**

The IBM SPSS software was used for analyzing the
The change in the gastric antral CSA and GV within the group was analyzed using the paired t-test. The Independent t-test was used to analyze the changes in gastric antral CSA and GV from baseline. Chi-square test was used to analyze the incidence of the appearance of comet tail artifacts. p-value < 0.05 was considered significant.

RESULT

Sixty patients were studied from January 2020 to March 2020. All the participants completed the study and the collected data was analyzed.

Both study group Sellick’s Maneuver (SM) and control group Non-Sellick’s Maneuver (NSM) groups were comparable in terms of age, anthropometry and baseline values of gastric antral CSA and GV [Table 1].

The change in gastric antral CSA and gastric volume (GV) after intubation and face mask ventilation (FMV) was found to be significant in group NSM and not in group SM [Table 2 and Figures 1, 2, 3 and 4].

The increase in gastric antral CSA after intubation and face mask ventilation (FMV) was smaller in group SM than in group NSM in supine and in right LDP. The change is calculated; gastric volume showed similar changes [Table 3]. Comet tail artefacts were seen more in group NSM when compared to group SM.

There was no difficulty during administration Sellick’s maneuver and intubation and face mask ventilation for any patient.

DISCUSSION

The main purpose of this study was to find the efficacy of Sellick’s maneuver in preventing gastric distension by using ultrasound. The gastric antrum CSA was measured in the supine position and right lateral decubitus position and then the gastric volume was calculated from gastric antral CSA by using a formula validated in a study conducted by Perlas et al. (2013).

From the results, it was found that there was a significant increase in gastric antral CSA and calculated gastric volume after intubation and FMV in the NSM group which did not receive Sellick’s maneuver when compared to the SM group in which the Sellick’s maneuver was performed. This indicates that Sellick’s maneuver is effective in preventing gastric distension due to insufflation of gas into the stomach during ventilation.

Furthermore, the incidence of the appearance of comet tail artifacts was comparatively less in the group in which Sellick’s maneuver was performed. Face mask ventilation before intubation has an increased risk of insufflation of gas into the stomach, which can lead to an increase in the intragastric buildup of pressure. It occurs because during anesthesia induction, protective airway reflex is lost and there is decreased lower esophageal sphincter...


Table 1: Characteristics of the study population

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Group SM (n=30)</th>
<th>Group NSM (n=30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>40.2 (19.3)</td>
<td>43.9 (20.6)</td>
</tr>
<tr>
<td>Sex (male/female)</td>
<td>18/12</td>
<td>16/14</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>163.5 (9.5)</td>
<td>160.43 (10.8)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>58.73 (10.33)</td>
<td>57.51 (9.67)</td>
</tr>
<tr>
<td>ASA physical status</td>
<td>14/16</td>
<td>13/17</td>
</tr>
<tr>
<td>Baseline supine CSA (cm²)</td>
<td>2.68 (0.78)</td>
<td>2.42 (0.96)</td>
</tr>
<tr>
<td>Baseline right LDP CSA (cm²)</td>
<td>2.92 (0.98)</td>
<td>2.72 (0.99)</td>
</tr>
<tr>
<td>Baseline supine gastric volume (ml)</td>
<td>19.81 (16.8)</td>
<td>14.42 (14.9)</td>
</tr>
<tr>
<td>Baseline right LDP gastric volume (ml)</td>
<td>21.93 (17.3)</td>
<td>18.65 (18.2)</td>
</tr>
</tbody>
</table>

Continuous data is expressed as mean (standard deviation); categorical data as counts; SM: Sellick’s Maneuver; NSM: No Sellick’s Maneuver; ASA: American Society of Anesthesiologists; CSA: Cross-Sectional Area; LDP: Lateral Decubitus Position; GV: Gastric Volume

Table 2: Gastric antral CSA and gastric volume before and after intubation and face mask ventilation in group SM and group NSM

<table>
<thead>
<tr>
<th>Group</th>
<th>Parameters</th>
<th>Before intubation and FMV</th>
<th>After intubation and FMV</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group SM</td>
<td>Supine CSA (cm²)</td>
<td>2.68 (0.78)</td>
<td>2.70 (0.80)</td>
<td>0.723</td>
</tr>
<tr>
<td></td>
<td>Right LDP CSA (cm²)</td>
<td>2.92 (0.98)</td>
<td>2.95 (0.96)</td>
<td>0.589</td>
</tr>
<tr>
<td></td>
<td>Supine GV (ml)</td>
<td>19.81 (16.8)</td>
<td>20.52 (16.71)</td>
<td>0.094</td>
</tr>
<tr>
<td></td>
<td>Right LDP GV (ml)</td>
<td>21.93 (17.3)</td>
<td>22.65 (17.52)</td>
<td>0.201</td>
</tr>
<tr>
<td>Group NSM</td>
<td>Supine CSA (cm²)</td>
<td>2.42 (0.96)</td>
<td>2.76 (1.09)</td>
<td>0.004*</td>
</tr>
<tr>
<td></td>
<td>Right LDP CSA (cm²)</td>
<td>2.72 (0.99)</td>
<td>3.46 (1.18)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td></td>
<td>Supine GV (ml)</td>
<td>14.42 (14.9)</td>
<td>19.68 (18.23)</td>
<td>0.003*</td>
</tr>
<tr>
<td></td>
<td>Right LDP GV (ml)</td>
<td>18.65 (18.2)</td>
<td>27.37 (23.22)</td>
<td>&lt;0.001*</td>
</tr>
</tbody>
</table>

Data presented as mean (standard deviation); SM: Sellick’s Maneuver; NSM: No Sellick’s Maneuver; CSA: Cross-Sectional Area; LDP: Lateral Decubitus Position; GV: Gastric Volume, FMV: Face Mask Ventilation; *p<0.05

Table 3: Change in gastric antral CSA and GV before and after intubation in SM and NSM group

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Group SM</th>
<th>Group NSM</th>
<th>The difference between the means</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in supine CSA (cm²)</td>
<td>0.02</td>
<td>0.34</td>
<td>0.32</td>
<td>0.1-0.6</td>
<td>0.014*</td>
</tr>
<tr>
<td>Change in right LDP CSA (cm²)</td>
<td>0.03</td>
<td>0.74</td>
<td>0.71</td>
<td>0.4-0.9</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Change in supine GV (ml)</td>
<td>0.71</td>
<td>5.26</td>
<td>4.55</td>
<td>0.7-6.4</td>
<td>0.019*</td>
</tr>
<tr>
<td>Change in right LDP GV (ml)</td>
<td>0.73</td>
<td>9.72</td>
<td>8.99</td>
<td>4.5-11.6</td>
<td>&lt;0.001*</td>
</tr>
</tbody>
</table>

Data is expressed as mean (standard deviation); SM: Sellick’s Maneuver; NSM: No Sellick’s Maneuver; CI: Confidence interval; CSA: Cross-Sectional Area; LDP: Lateral Decubitus Position; GV: Gastric Volume; *p<0.05

All these factors contribute to increased risk for regurgitation of gastric and esophageal contents to the pharynx, which can then be aspirated into trachea or lungs, causing aspiration (Loganathan and Liu, 2012; Morgan et al., 2006).

It is for this reason that face mask ventilation is not generally preferred before the patient is intubated, but in some situations when intubation failure occurs, or patients suffering from conditions of low functional residual capacity like severe respiratory pathology or obesity there is an increased risk of the patient undergoing hypoxemia (Vanner and Asai, 1999; Herman et al., 1996; Loganathan and Liu, 2012). Sellick et al. tested the theory by applying the maneuver during induction of anesthesia in patients considered to be at high risk of aspiration. In some patients, regurgitation occurred immediately after...
the release of cricoid pressure following successful intubation (Sellick, 1961).

Sellick’s maneuver is effective in these kinds of scenarios as the patient can be given face mask ventilation while preventing entry of gas into the stomach by occlusion of the upper part of the esophagus.

Similar results were reported by Vasudevan et al. who conducted a randomized control trial among 82 patients to test the efficacy of cricoid pressure in preventing gastric insufflation and found that post FMV gastric volume was significantly higher in control group indicating gastric insufflation when compared to study groups receiving cricoid pressure (Vasudevan et al., 2018).

There are some studies regarding controversies of Sellick’s maneuver.

Ellis et al. reported that there is increased difficulty in tracheal intubation and ventilation while applying pressure on cricoid cartilage (Ellis et al., 2007).

Smith et al. reported that application of cricoid pressure increased lateral displacement of esophagus preventing effective occlusion of the esophagus and proposing that Sellick’s maneuver was not very effective (Smith et al., 2003).

Vanner et al. reported that these difficulties arise due to improper application of Sellick’s maneuver. Excessive pressure might have been applied, the wrong direction of application of pressure or application of pressure on larynx rather than cricoid cartilage or relieving the cricoid pressure too soon (Vanner and Asai, 1999).

It must be ensured that the pressure is applied to the cricoid cartilage, the pressure is applied correctly to the backward direction, the correct amount of force applied is that up to 10 N in a conscious patient and up to 30 N in an unconscious patient, the pressure should be applied for the correct duration of time for proper technique (Vanner and Asai, 1999; Wraight et al., 1983; Herman et al., 1996). Sellick’s maneuver should be performed correctly in patients who have a high risk of aspiration.

Medical practitioners can be trained to apply proper cricoid pressure using infant scales and cricoid models for proper application of Sellick’s maneuver (Owen et al., 2002).

CONCLUSION

Sellick’s maneuver is effective in preventing gastric distension due to insufflation of gas into the stomach during mask ventilation and can thus help in reducing the risk of regurgitation. Therefore for patients who are at high risk for regurgitation, it is safer to apply Sellick’s maneuver to prevent pulmonary aspiration.

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Conflict of Interest

The authors declare that they have no conflict of interest for this study

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