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Review Article

Cricoid pressure controversies

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ABSTRACT

Rapid sequence induction (RSI) is a common technique used in clinical anaesthesia to prevent pulmonary aspiration of gastric contents. Sellick introduced this in 1961. However, scientific validation to show the advantage of this technique in preventing aspiration is limited in literature. Numerous researches have shown that cricoid pressure (CP) application might have no benefit in preventing aspiration. Additionally this could lead to problems in securing the airway. Proper teaching and regular training sessions of this technique are mandatory in routine anaesthesia practice.

Keywords: Aspiration, Airway, Cricoid pressure, Rapid sequence induction

INTRODUCTION

Rapid sequence induction is a frequently used technique in anaesthesia practice in patients suspected of having full stomach and at risk of aspiration of gastric contents into the lungs. Walls et al in their longitudinal multicentre study on 8937 emergency patients undergoing tracheal intubations reported that in 69% patients (6138 out of 8937) RSI was method of choice.[1] Sagarin et al in their prospective observational multicentre study concluded that in 78% of attempts of intubation, RSI resulted in 85-91% success rates.[2] Additionally in another study by same author found that 81% of paediatric patients underwent RSI during emergency intubations and had high success rate of 78% and low complication rate (1%).[3] RSI is also most commonly used method during securing airway in intensive care unit (ICU) patients.[4] Sequence of events during RSI includes prevention of hypoxia during induction and intubation, achieved by preoxygenation with 100% oxygen for 3-5 minutes prior to induction of anaesthesia. Objective of minimizing lag time between induction and intubation is attained by use of fast onset induction agent and neuromuscular blocker. Then cricoid pressure (CP) is applied to prevent pulmonary aspiration of gastric contents. Alongside, intermittent positive pressure ventilation is avoided. Cricoid pressure application is continued until endotracheal tube is secured and its cuff inflated.[5]

METHODS

A lot of literatures highlighting potential pros and cons of using cricoid pressure during induction. We tried to compare latest studies in this field. This article tries to review various researches related to cricoid pressure use in anaesthesia. Extensive search was conducted through Medline, Pubmed, and Google Scholar using key words Rapid sequence induction, Cricoid pressure, Aspiration, Airway and Sellick's manoeuvre. Relevant studies were selected. This narrative review touches various aspects of use of cricoid pressure in anaesthesia.

HISTORY

Cricoid pressure application was used as early in 1774 (Monro) during resuscitation of drowning victims.[6]

Sellick in 1961 described a maneuver to prevent aspiration of regurgitated gastric contents during induction of anaesthesia which involved backward pressure on cricoid cartilage to temporary occlude upper esophagus. This would prevent gastric contents from reaching pharynx in case regurgitation occurs.[7] Since then Sellick's maneuver became a part of emergency and anaesthesia practice during RSI.

However, Sellicks's original article was not specific regarding application of CP. Additionally. There is paucity of trials validating the application of CP in literature. Various authors like Butler et al and Fenton et al have evaluated available literature to check for favourable outcomes of using CP. Nevertheless, they found no evidence supporting use of Sellick's maneuver.[8,9]

Authors have even pointed out that frequency of morbidity due to aspiration is so common (0.15% in adult patients), that a sample size of 25000 would be required in each group of patients if a randomized controlled trial (RCT) planned.[10]

ANATOMICAL PERSPECTIVE

Reviewing the anatomy, larynx is a cartilaginous organ covered by epiglottis at the base of tongue. Epiglottis prevents aspiration by covering the glottis during act of swallowing.[11] Cricoid cartilage is a complete ring. Esophagus begins at the lower part of cricoid ring. CP supposedly compresses the upper esophagus against body of sixth cervical vertebra.[12] Authors have challenged anatomical basis of CP. Schmalfuss et al in their study correlated CT and MRI images and showed that esophagus starts one centimetre below the lower end of cricoid cartilage.[13]

Rice et al demonstrated on MRI studies that post cricoid hypo pharynx and not esophagus lies distal to cricoid cartilage.[14] Also Tsung et al observed on ultrasonography that esophagus lied lateral to trachea on application of cricoid pressure.[15]

Smith et al also echoed similar findings that in 49% of normal subjects, esophagus was aligned lateral to cricoid cartilage on CT scan images. In addition, it was found on MRI that lateral displacement of esophagus was in 52.6% patients without CP and 90.5% with CP. Airway compression resulting from CP was seen in 81% subjects.[16]

HOW EFFECTIVE IS CP?

The research conducted by Sellick had some major limitations. It was a non-randomized trial. During induction of anaesthesia, subjects were placed in slight head down and head turned position. Sellick reported 12% incidence of regurgitation after release of CP. In addition, details of the drugs and sequence of administration of induction agent as well as muscle relaxant are missing in the report. In addition, how much force was applied during CP is not described.[17] Vanner and Pryle demonstrated lateral esophageal displacement on CT scans during application of CP.[18]

Rice et al also found that hypo pharynx present behind cricoid cartilage was compressed by CP. Due to lateral displacement of cricoid hypo pharynx unit or CP unit, the hypo pharynx is compressed between cricoid cartilage and longus colli muscle. Although upper esophagus is not compressed as proposed by Sellick, but hypo pharynx does compresses and helps in preventing regurgitation of stomach contents.[14]

Similar findings were echoed by Zeidan et al.[19] Various other early reports are available on effectiveness of CP but they are mainly based on cadavers.[20,21] Numerous case reports and studies point towards the unreliability and possibility of aspiration despite use of CP.[22] Glaring among these is a prospective study on 297 critical patients in which 12 showed signs of pulmonary aspiration pneumonitis in spite of using CP while intubation in 9 of them.[4]

In addition, out of 5000 obstetrical patients under general anaesthesia, 11 patients died of regurgitation despite using CP in nine out of 11.[9] However, other authors have proposed that these incidents could have been due to improper technique, administration by untrained personnel, early release, aspiration before induction or after extubation.[23-25]

Perioperative aspiration in routine settings is estimated to be 0.014%-0.1% in adults.[26] However, this incidence escalates much higher in situations of emergency surgery and intubations especially with repeated attempts of intubation as well as in patients having American society of anaesthesiologists (ASA) status 3 and 4.4.[27]

A survey of 2833 emergency intubations showed a 1.9% incidence of aspiration which hiked to 22% with three or more attempts of intubation. Moreover, mortality from perioperative aspiration has been reported to be as high as 4.6%.[28] Authors have also reported aspiration of gastric contents as single most common anaesthesia related cause of death, accounting for 50% of mortality and prolong morbidity.[29] There is lack of RCTs comparing incidence of aspiration with and without CP.

MAGNITUDE OF CRICOID PRESSURE

Sellick used terms 'moderate' and 'firm' pressure in his study.[7] According to Wraight et al, assuming intragastric pressure to be 59 mm Hg in 50% patients, recommended CP force was 44 Newton (N).[29] Another study revealed that CP force of 20N was enough to prevent regurgitation at intragastric pressure of 25 mm Hg and 30N force prevented regurgitation at 40 mm Hg.[30]

Studies have shown that under anaesthesia intragastric pressure is less than 15 mm Hg.[31] Even pregnant females undergoing emergency caesarean sections have pressures less than 25mm Hg.[32] On basis of these researches 20N force has been found to be adequate. It is recommended that 10N force should be applied when patient is awake which is to be increased to 30N on loss of consciousness.[23]

AIRWAY IMPLICATIONS OF CP

Airway obstruction

Airway patency compromise difficult mask ventilation, endotracheal tube insertion, rail roading the tube over bougie, problems in visualisation during fibre optic scopy have been reported due to excess cricoid force application.[33,34]

Inversely, a study conducted on 700 elective surgical patients did not increase rate of failed intubations.[34] Airway obstruction depends on the force and technique of application.[35] One study has shown that 44N force causes airway obstruction in 35% patients while only in 2% cases in case force applied is 30N.[34] In case of paediatric patients, 10.5N is sufficient to cause airway obstruction. It is 5N for infants and 15-25N in teenagers.[36] In fact; German society of anaesthesia and intensive care medicine has recommended not using cricoid pressure in children.[37]

Laryngeal view and CP

Various studies have evaluated the laryngoscopic view during CP application. Though CP improves the laryngoscopic view, it may worsen it in 14-45% of cases.[38] A recent study also concluded that tracheal intubation is hindered using CP.[39]

Use of neck support by using a neck pillow or by bimanual CP has shown to improve laryngoscopic view during CP. In this technique, one hand performs the CP and other is placed below the neck for support.[40]

Supraglottic airway devices and CP

In case of LMA insertion, CP is applied before insertion, it may lead to malpositioning of LMA and problem in ventilation.[41] CP application after LMA insertion also impedes ventilation.[42]

In case of fiberoptic intubation through LMA, CP application before LMA insertion leads to successful intubation only in 15% cases, which is otherwise 89-95% without CP. If CP is applied subsequent to LMA insertion, successful fiberoptic intubation is seen in 60% cases and intubation time is prolonged.[41,43] I gel placement may also be difficult along with CP application.[44]

Seeing complexity of the situation, researches have recommended that in patients with difficult airway who is at high risk of aspiration, awake intubation is advisable.[43,45]

NASOGASTRIC TUBE AND CP

Sellick recommended suctioning and removal of Ryles tube before CP application. He hypothesised that presence of nasogastric tube might lower the tone of upper and lower oesophagus sphincters.[7] However, studies have confirmed that CP is effective even in presence of nasogastric tube.[21]

Salem et al have proposed that nasogastric tube should be connected to working suction while applying CP during induction to prevent rise in intragastric pressure.[46]

COMPLICATIONS

Nausea and vomiting in awake patients, airway obstruction, oesophageal rupture, cricoid cartilage fracture, worsening of cervical spine injuries are other reported complications of CP.[33,35,47,48]

TEACHING THE PROPER TECHNIQUE

Researchers have reported that large number of operators (47-63%) applies CP in an improper way.[24,49] Brisson and Brisson in their study noticed a large variability in technique of CP application, which can lead to wrong application of cricoid pressure. They recommended the 'three finger technique' as advised by Sellick.[49] Armstrong et al have explained that CP should be started as soon as patient loses consciousness and should be continued till endotracheal tube is in place with inflated cuff and EtCO¬2 curve is observed.[50]

Kopka et al and Flucker et al have recommended that application of correct amount of force while CP application should be practiced regularly on monthly basis using a 50 ml syringe plunger. 50 ml syringe filled with 50 ml air. After capping and placing upright plunger is pressed by 12 ml for 20N force and 17 ml for 30N force.[51,52]

In addition to three-finger technique (single-handed) which is used popularly, double-handed (bimanual) technique may also be used especially for trauma and obstetric patients. Advantages include prevention of head flexion, stabilization of cervical spine and better visualization of larynx.[40,48] In recent guidelines, use of CP during cardiac arrest is not recommended.[33,35,53-55]

Many devices has been described to help in cricoid compression, these include cricoid yoke, cricoid pressure measuring device using wedge and pin combination, force sensitive resistors to estimate cricoid force. Use of floor weighing machine has been used also with success. Operator stands on weighing scale then CP is applied

until weight reading on weighing machine reduces by 2.5 to 3.5 kg less than original weight of operator. It means that 25-35N force has been applied (1 kg: 9.8N). Use of simulators has been demonstrated for training and teaching application of CP. [56-59]

CONCLUSION

Some anaesthesiologists have proposed to abandon the use of cricoid pressure. However, the findings that aspiration largest cause of anaesthetic related deaths and morbidity has lead clinicians to rethink regarding this issue. Although pulmonary aspiration has occurred despite use of CP as described in various studies it is suggested that CP may not have been applied properly or may have been released prematurely etc.

Important is to assess the risks and benefits of using CP on case to case basis, more randomised controlled trials are awaited in this subject. In addition, stress on proper and periodic training of anaesthesiologists in this very commonly used controversial and still important technique is the need of hour.

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