Cricoid pressure: ritual or effective measure?

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ABSTRACT Cricoid pressure has been long used by clinicians to reduce the risk of aspiration during tracheal intubation. Historically, it is defined by Sellick as temporary occlusion of the upper end of the oesophagus by backward pressure of the cricoid cartilage against the bodies of the cervical vertebrae. The clinical relevance of cricoid pressure has been questioned despite its regular use in clinical practice. In this review, we address some of the controversies related to the use of cricoid pressure.

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INTRODUCTION

Cricoid pressure is a technique used worldwide to reduce the risk of aspiration during tracheal intubation in sedated or anaesthetised patients. Cricoid pressure can be traced back to the late 18th century when it was used to prevent gas inflation of the stomach during resuscitation from drowning.[1] Sellick noted that cricoid pressure could both prevent regurgitation of oesophageal/gastric contents as well as gastric insufflation during mask ventilation.[2,3] Sellick advocated its use in patients at risk of pulmonary aspiration after studying cricoid pressure in a small group of patients in 1961.[2] He had used a Trendelenburg (head lower than feet) position in his patients, which is not commonly used during airway management in current practice.[2] This technique has been adopted by clinicians, emergency physicians, paramedics and anaesthetists worldwide. The effectiveness of cricoid pressure has been questioned, but its use in patients at risk of aspiration may even seem to be ritual. In this review, we summarise some of the controversies surrounding the use of cricoid pressure.

MECHANISM OF CRICOID PRESSURE

With the induction of general anaesthesia, there is loss of the protective airway reflexes. Stomach contents that have been regurgitated and have reached the pharynx can be aspirated into the trachea and lungs. Aspiration is a particular risk of anaesthesia in patients who have full stomachs, raised intragastric pressure or impaired function of the lower oesophageal sphincter such as in hiatus hernia.[4] The lower oesophageal sphincter tone also decreases during general anaesthesia. The mechanism of cricoid pressure is thought to be compression and occlusion of the upper oesophagus between the cricoid cartilage and cervical vertebral column. This occlusion prevents refluxed gastric contents in the oesophagus from reaching the pharynx. For it to be effective, cricoid pressure should reduce the rate of aspiration in at-risk patients, and it should not cause harm.

Earlier work by Smith et al using computed tomography imaging showed that in 49% of patients in whom cricoid pressure was applied, the oesophageal position was lateral to the cricoid ring.[5] As oesophageal occlusion was thought to be crucial, this study challenged the efficacy of cricoid pressure. More recently, in magnetic resonance imaging studies, Rice et al showed that cricoid pressure causes compression of the post-cricoid hypopharynx rather than the oesophagus itself. They found that the lumen of the distal hypopharynx was likely to be occluded and that this occlusion was maintained even when the cricoid ring was lateral to the vertebral body.[6] This concept of the 'cricoid hypopharynx anatomic unit' is thus central to the efficacy and reliability of Sellick's manoeuvre.

PREVENTION OF GASTRO-OESOPHAGEAL REGURGITATION INTO THE HYPOPHARYNX AND PULMONARY ASPIRATION

While cricoid pressure may cause compression of the hypopharynx, such compression must prevent any stomach contents that enter the oesophagus from reaching the hypopharynx. Fanning in 1970 used human cadaveric models to demonstrate that cricoid pressure could prevent regurgitation into the hypopharynx at intra-oesophageal pressures of at least 50 cmH_2O, and in some cases, at significantly higher pressures.[7] Cricoid pressure has also been applied to prevent inflation of the stomach during artificial ventilation. Salem et al showed that cricoid pressure could prevent gastric inflation during facemask ventilation and mouth-to-mouth resuscitation in paediatric patients. Preventing gastric inflation would also help in preventing the build-up of intragastric pressure, which may also reduce the risk of regurgitation.[8]

Pulmonary aspiration of regurgitated stomach contents is uncommon, and the estimated incidences vary from 0.02% to 0.1% of general anaesthesia cases.[9] There are no published randomised controlled trials studying the effectiveness of cricoid pressure in preventing aspiration. As aspiration is a relatively rare event, a huge clinical trial would be required to show a significant

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difference in aspiration incidence. It is unlikely that such a trial will be carried out. Even if a randomised trial is carried out, it will be difficult to isolate the benefits of cricoid pressure from other manoeuvres such as oxygenation, rapid sequence induction, use of suxamethonium, as well as the skill of the anaesthetists and their assistants. There are also ethical considerations and objections to any randomised trial of what is considered an established safety procedure.

Observational work and surveys may help in evaluating the effectiveness of cricoid pressure. In a survey of anaesthetists in the UK, 10% of respondents noted that they had witnessed regurgitation of gastro-oesophageal contents into the pharynx despite the application of cricoid pressure. However, 50% noted that they had witnessed regurgitation after the release of cricoid pressure, suggesting that cricoid pressure had been effective in preventing oesophageal contents from reaching the hypopharynx, thus reducing the risk of aspiration before successful tracheal intubation.[10] Neelakanta observed that gastric fluid appeared in the mouth upon release of cricoid pressure in a patient post-oesophageal reconstruction, who was having an unrelated ocular surgery under general anaesthesia.[11] Such observations suggest that cricoid pressure can be effective, although not in all cases. Sellick himself noted that three of his subjects had reflux of gastric contents after cricoid pressure was released post-tracheal intubation. This also supports that cricoid pressure was effective in preventing gastric contents reaching the pharynx before tracheal intubation was achieved.[2]

LIMITATIONS OF CRICOID PRESSURE

Even though cricoid pressure is widely used, there are several limitations to consider. Of concern is the appropriate amount of force with which cricoid pressure should be applied. In 1983, Howells et al found that 50% of patients would be protected by 44N of cricoid pressure and 83% would be protected by 66N (applied cricoid force).[10] The ability of the assistant to correctly apply cricoid pressure is crucial. The appropriate pressure should occlude the oesophagus but not distort the laryngeal anatomy.[5,12] Even though the cricoid cartilage is a complete ring, excessive pressure could result in its distortion and occlusion of the airway, especially in children. Too much force may distort the anatomy and laryngoscopic view, and lead to prolonged and difficult intubation. Too little force will result in ineffective occlusion of the hypopharynx and permit regurgitation of gastric contents. Our current understanding is that a force of 30N–44N is optimal in occluding the hypopharynx while not distorting the laryngeal anatomy.[12-14] Cricoid pressure will be better replicated clinically with enriched knowledge and improved performance in practical training.[14]

The effectiveness of cricoid pressure when there is a naso- or orogastric tube in place has been questioned. The concern is that the tube may prevent complete compression of the upper oesophagus, allowing oesophageal contents to reach the hypopharynx. Early work by Salem et al in human cadavers showed that even in the presence of a gastric tube, cricoid pressure had prevented regurgitation of oesophageal and gastric contents into the hypopharynx up to 100 cmH_2O of intra-oesophageal pressure. A gastric tube may even enhance the effectiveness of cricoid pressure by occupying the portion of the upper oesophageal sphincter that is not compressed by cricoid pressure.[15] Another concern is that the presence of a gastric tube will prevent the lower oesophageal sphincter from closing off the gastro-oesophageal passage. However, a gastric tube can also be used to decompress the stomach, reducing the intragastric pressure and risk of regurgitation.

HARM FROM CRICOID PRESSURE

Cricoid pressure can cause complications. Among the most severe is oesophageal rupture when the patient vomits, as cricoid pressure prevents the egress of oesophageal contents that are under pressure.[16,17] Cricoid pressure may cause harm in patients with cervical spine or laryngeal trauma. There can be significant movement of the cervical spine during the application of cricoid pressure, although there is no conclusive study that this increases the risk of spinal cord injury in patients with cervical spine injury.[18] Cricoid pressure can even cause fracture of the cricoid cartilage and complete airway obstruction.[19,20] Cricoid pressure with a force > 20N can also cause retching in awake patients.[21]

More commonly, cricoid pressure may make mask ventilation, laryngoscopy and tracheal intubation more difficult, especially in the presence of pre-existing features of difficult airway management.[22] In difficult airway situations, the priority is oxygenation; the negative effects of cricoid pressure can be quickly reversed by releasing pressure on the cricoid cartilage. A study involving emergency physicians recommended that cricoid pressure should be removed if the laryngeal view is suboptimal in order to facilitate rapid tracheal intubation.[23] Perhaps more imaging studies can be carried out to assess the ease at which intubation can be done in the presence of cricoid pressure.

Furthermore, cricoid pressure can prevent successful insertion of laryngeal mask airways (LMA). The success of LMA insertion can be reduced from 94% to 67%.[24] Correct LMA positioning does require insertion of the tip of the LMA cuff into the upper oesophagus; hence, this is impeded when the upper oesophageal sphincter is compressed by cricoid pressure.[25]

IMPROVING THE APPLICATION OF CRICOID PRESSURE

Some training may increase the correct application of cricoid pressure with the appropriate force of 30N–44N.[13] Using the same force as that which when applied on one's own nose would cause pain, may help in applying the correct pressure.[13,14] Another surrogate measure is the pressure on one's own cricoid that will prevent swallowing.[21] Although using a cricoid yoke can help with consistent force,[26] it can still cause deformation of the cricoid.[27] Cricoid yokes are, however, not widely used. Training with infant scales and

cricoid models may help,[28] but it is still difficult to apply a consistent pressure even after training.

CONCLUSION

In choosing whether to use cricoid pressure, we do have to consider prevailing medical and legal opinions. Cricoid pressure is unlikely to be 100% effective (few treatments are 100% effective), and regurgitation and aspiration may still occur even if cricoid pressure is used. While patients and their lawyers may not appreciate this, it may be difficult to defend omitting cricoid pressure during rapid sequence induction in patients at risk of aspiration.

Perhaps our focus should be on improving the application of cricoid pressure and knowing when to release or avoid using cricoid pressure. We should also use collective measures to reduce aspiration risk and to improve the ease of laryngoscopy and tracheal intubation. Cricoid pressure can be immediately released should it cause distortion of the anatomy or render laryngoscopy or mask ventilation difficult. Failure of ventilation and oxygenation is of immediate and greater concern compared to the risk of aspiration. In summary, even if cricoid pressure may have been adopted as a ritual, it can be effective when applied appropriately and prudently.

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