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COMMENTARY

Cricoid pressure: The case in favour

Vassilis Athanassoglou [a], Jaideep J. Pandit [a, b, *]

[a] Nuffield Department of Anaesthetics, Oxford University Hospitals NHS Trust, Oxford, UK
[b] St John's College, Oxford, UK

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SUMMARY

Cricoid pressure (CP) was introduced into anaesthetic practice in the 1960s and has become the standard of care for patients at risk of aspiration during induction. However, the evidence supporting the widespread use of CP to prevent aspiration remains unconvincing. Equally, there is no robust evidence to suggest that CP causes harm, and as such, CP has become an established technique because of a mixture of anecdotal evidence and expert opinion. The future of CP lies in the answer to the question as to whether it is actually effective in preventing regurgitation or whether it is an unnecessary hazard.

1. Introduction

Cricoid pressure (CP), as a means of preventing gastric distension, was first reported by Monro in 1774 during inflation with bellows of the lungs of persons "drowned and seemingly dead" and it was recognised that during resuscitation of near-drowning victims pressure should be applied on the cricoid ring to prevent air from entering the stomach.[1]

There was no further mention of CP until Sellick, in 1961, reported using "occlusion of the upper oesophagus by backwards pressure on the cricoid ring against the bodies of the cervical vertebrae to prevent gastric contents from reaching the pharynx" and thus subsequent aspiration into the lungs during induction of anaesthesia in patients at high risk of aspiration.[2] This came fifteen years after Mendelson, who in 1946, reported the risk of pulmonary aspiration of gastric contents during mask anaesthesia.[3]

Cricoid pressure, or Sellick's manoeuvre, is the application of sustained digital pressure to the cricoid cartilage pushing it backwards and thus compressing the oesophagus between the posterior aspect of the cricoid and the body of C5–6. Sellick's conclusion was based on evidence from lateral neck X-rays. The cricoid cartilage is used because it forms the only complete ring of the larynx and trachea. It has traditionally been considered an integral part of patient safety in rapid sequence tracheal intubation and emergency airway management due to it being intuitively helpful in preventing regurgitation of gastric contents.[4]

Before the routine use of CP, maternal death from inhalation of stomach contents was a leading cause of death from anaesthesia in England and Wales. Although CP was first described in 1961, it was not in widespread use until about 1970. In the Confidential Enquiries into Maternal Death in England and Wales from 1964 to 1969 there were 52 deaths from aspiration.[5] In the last five triennial reports of the Confidential Enquiries into Maternal Death in the UK from 1994 to 2005 there have been only three deaths from aspiration pneumonitis.[5–8] One patient did not have CP applied,[7] and the other aspirated after failed intubation and may have had CP released at that time.[7] There was one death in the Centre for Maternal and Children Enquiries (CMACE) 2011 report, attributed to aspiration of gastric contents.[9] However, in that case aspiration occurred at extubation post caesarean section.[9]

2. The current practice

The goal of CP is prevention of regurgitation of gastric contents, with subsequent aspiration into the lungs. Some authors have described CP as the "lynchpin of physical prevention of aspiration" and a minimum standard of care, implying any clinical trials to 'prove' its worth could be unethical.[10] Its continued use during rapid sequence induction (RSI) is based on anecdotal evidence and expert opinion.[11] It has become the standard of care and it is unlikely that a large randomised controlled trial (RCT) will be done to assess its role in high-risk patients as it would be unethical for half of the subjects at risk to be denied a technique that is regarded as a

* Corresponding author. Nuffield Department of Anaesthetics, Oxford University Hospitals, Oxford OX3 9DU, UK. Tel.: +44 1865 221590; fax: +44 1865 220027.
E-mail address: jaideep.pandit@dpag.ox.ac.uk (J.J. Pandit).

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standard of care. Equally, there is no robust evidence to suggest that CP causes harm, and perhaps this aspect has made it an established technique.[11,12,13]

However, in recent years it has come under considerable scrutiny and some criticism, with some authors even arguing for its abandonment.[14] There have been two systemic reviews in the past that concluded that there was no evidence for or against the application of CP.[15] Three reviews on rapid sequence induction and CP have all pointed out that there are no published randomized controlled trials comparing the incidence of regurgitation on induction, with and without CP in patients at high risk of regurgitation.[14,16,17] Cook et al. found that 11% of anaesthetic assistants surveyed had experienced regurgitation in their patients despite application of CP.[18] Fenton and Reynolds (2009) in their study of the application of CP and maternal outcome in patients undergoing caesarean sections in Malawi argue that its efficacy in saving lives is difficult to establish. They concluded that there was no evidence that CP prevented regurgitation and saved lives.[19] However, Vanner, in an editorial, gave a more balanced view. He argued that CP has led to the reduction of deaths from regurgitation and aspiration in the UK.[20] There are often anecdotal arguments that French anaesthetists do not apply CP; however, a survey of French anaesthetists in 1998 showed that the overwhelming majority do routinely apply CP.[21] Moreover, a French RCT comparing the effectiveness of CP in the incidence of regurgitation in high-risk patients showed no regurgitation in the CP group compared with three patients in the non CP group.[22]

Advocates of CP contend that its incorrect application is the main reason for the reported problems rather than any fundamental deficiency of the method.[1,15] Incorrect timing, the use of excessive force, and compressing the thyroid cartilage instead of the cricoid cartilage are examples of misuse of CP. Advocates also stress the added benefit of the ability of CP to prevent gastric insufflation when mask ventilation is needed before tracheal intubation.[23] Vanner and Asai noted that especially the force used in CP was a relevant factor in its success in preventing regurgitation of gastric contents.[24]

3. How big is the problem of aspiration?

Since the initial comprehensive review of the incidence of pulmonary aspiration, in obstetric patients, by Mendelson in 1946,[25] several large retrospective observational studies have been published.[25–29] Most of these reports concentrated on either the paediatric population[25,26] or mixed populations[28,29] and only one study focused on the adult surgical/obstetric population.[27]

The incidence of aspiration in the general surgical population has been reported in three large studies. Olsson et al. found an aspiration incidence of 1:2131 during anaesthesia in 185,385 patients, with a mortality rate of 1:45,454. Forty-seven per cent of the patients who aspirated developed pneumonitis and 17% required lung ventilation.[28] In a study of 85,594 adult surgical patients by Mellin-Olsen et al. calculated the incidence of pulmonary aspiration being 2.9:10,000, all in patients undergoing general anaesthesia. The incidence was four times greater in emergency cases.[29] A retrospective review of >200,000 patients in the Mayo Clinic revealed an aspiration rate of 1:3,216, with a mortality rate of 1:71,829.[27]

In children, the risk of regurgitation and pulmonary aspiration may be greater but it is rarely associated with pneumonitis.[30,31] With regards to obstetric anaesthesia, patients undergoing Caesarean section under general anaesthesia have at least twice the risk of pulmonary aspiration when compared with the general population. An Italian study quoted an incidence of aspiration between 1:1431 and 1:1,547, whereas a more recent study reported aspiration in 1:900 patients undergoing Caesarean section.[32,33]

4. The key questions

To decide whether or not the practice of CP should be continued or not we need to be able to answer two questions: 1) Does CP prevent stomach inflation during manual lung ventilation? and 2) Does CP prevent regurgitation and aspiration?

4.1. The evidence for CP preventing stomach inflation

The initial supporting evidence for CP came from relatively small cadaveric studies. Yet, the difference between a cadaveric response to regurgitation and the response of an anaesthetised human is poorly defined.[34] The interplay between the upper oesophageal sphincter, lower oesophageal sphincter, and intragastric pressure is a complicated dynamic process that cannot be replicated in non-responsive tissue. The tone of the sphincters and the degree of intragastric pressure varies significantly between cadavers, patients in cardiac arrest, obtunded emergency patients and elective patients.[35–38]

The application and success of CP involves many variables, including the operator and patient. The effectiveness of CP in preventing regurgitation is likely to vary on the method of application, as well as the ventilation technique and other patient-specific variables. Imaging studies suggest that the differing results of CP may be due to variability in the anatomic relationships between the cricoid ring, the oesophagus, and the vertebral body. On CT and MRI imaging the application of CP increased the lateral displacement of the oesophagus.[39,40] Considering the mobility of the larynx relative to the oesophagus, coupled with operator variability, CP is unlikely to provide uniformly effective oesophageal compression. There is solid evidence that cricoid pressure is applied inconsistently.[41,42] In other words, the argument as to whether CP is effective or not should revolve around whether it is employed correctly or not (i.e, without excessive force, at the correct location, at the appropriate time). CP should be highly patient-dependent and the focus should be taken away from the prescriptive application of force on the cricoid ring.

There are at least two aspects to ‘success’ of CP. First, is the extent to which a certain applied force demonstrably occludes the oesophagus without causing other forms of anatomical disruption to neighbouring tissues. Second is whether this anatomically optimal result yields a beneficial functional result in preventing gastric distension or regurgitation.

Sellick, in his original description, suggested that correct application of CP would prevent gastric insufflation during bag-valve-mask ventilation. He found that gastric inflation was unlikely to occur if inflation pressure did not exceed 15–20 cm H_2O.[2]

There is a relationship between the pressure required to ventilate the lungs and that forcing air in the stomach. Airway pressures below 16 cm H_2O, even without CP, rarely lead to insufflation of air in the stomach.[43,44] Application of CP increases the applied airway pressure that is needed before air enters the stomach.

Studies have shown that CP prevented gastric insufflation in adults and children being ventilated with high tidal volumes and inspiratory pressures.[43–45] Provided peak inspiratory pressure does not exceed 35 cmH_2O, ventilation with bag-valve-mask should not lead to gastric insufflation. CP applied during facemask ventilation prior to laparoscopic cholecystectomy was shown to prevent gastric insufflation.