Choking on a foreign body: a physiological study of the effectiveness of abdominal thrust manoeuvres to increase thoracic pressure

ABSTRACT The Heimlich manoeuvre is a well-known intervention for the management of choking due to foreign body airway occlusion, but the evidence base for guidance on this topic is limited and guidelines differ. We measured pressures during abdominal thrusts in healthy volunteers. The angle at which thrusts were performed (upthrust vs circumferential) did not affect intrathoracic pressure. Self-administered abdominal thrusts produced similar pressures to those performed by another person. Chair thrusts, where the subject pushed their upper abdomen against a chair back, produced higher pressures than other manoeuvres. Both approaches should be included in basic life support teaching.

BACKGROUND Foreign body airway obstruction (FBAO) is a common cause of death, particularly in older people. The National Safety Council USA reports that FBAO is the fourth leading cause of unintentional injury death, with 4864 reported deaths in 2013. The ‘Heimlich’ manoeuvre is a technique for expelling an obstructing food bolus where a first-aider places their arms round the subject from behind and delivers a sharp inward and upward thrust to the abdomen below the rib cage. Heimlich described 162 cases where life was saved following successful administration of abdominal thrusts.

European Resuscitation Council guidance for treatment of FBAO in conscious adults is a combination of back blows and abdominal thrusts with no preference on order. The Australian and New Zealand Resuscitation Councils recommend back blows and chest thrusts for the management of FBAO in conscious adults, but advise against abdominal thrusts, citing concern about complications.

External pressure on the abdomen should be transmitted through the diaphragm regardless of where it is applied, so there is no theoretical reason why force needs to be directed upwards. Motivated in part by three cases of near death from choking involving UK chest physicians (see online supplement), we describe experiments to address these two questions.

METHODS Detailed methods are available in the online supplement. Briefly, different expulsive manoeuvres (see box 1) were performed on and by four consenting adult physiology researchers median (range): age 56.5 (46, 74) years and body mass index (BMI) 25.9 (25, 26) kg/m². Oesophageal and gastric balloon catheters were placed to record pressures generated. Detailed statistical analysis is available in the online supplement.

Box 1 Description of manoeuvres

<table>
<thead>
<tr>
<th>Description of manoeuvres</th>
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<tr>
<td><strong>Circumferential ‘horizontal’ abdominal thrust</strong></td>
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<td>The operator stands behind the participant, grasps their fists together and places thumb side of the fist over the fleshy part of the abdomen above the navel. The operator pulls sharply backwards starting with medium force and progressively increasing force, until the maximum pressure that the subject feels is acceptable is achieved.</td>
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<tr>
<td><strong>Heimlich manoeuvre</strong></td>
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<td>The same procedure but with an upward direction of force.</td>
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<td><strong>Auto ‘upthrust’ abdominal thrust</strong></td>
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<td>The participant positions their own hands in the standard position for the abdominal manoeuvre and performs thrusts increasing to the maximal force they can tolerate.</td>
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<tr>
<td><strong>Chair thrust</strong></td>
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<td>The participant positions themselves above a high backed chair, with the chair back positioned below the upper half of the abdomen, below the ribcage. Using gravity, bodyweight and arms for additional force, the participant allows the back of the chair to thrust up into their abdomen (see figure 1).</td>
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<tr>
<td><strong>Volitional maximal cough and sniff pressures</strong></td>
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<td>The participant performed repeated maximal volitional cough and sniff manoeuvres. All manoeuvres were performed after exhalation to the end of a normal breath (at functional residual capacity) with mouth and glottis closed and a noseclip in situ.</td>
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Figure 1 One of the authors (MH) performing a chair thrust on himself (see also online supplementary video).
Abdominal thrusts were as effective or more effective than operator-delivered thrusts and indeed they had been used successfully in two of our cases (online). Repeated manoeuvres can be performed quickly and effectively without relying on an external operator. People choking may be encouraged to try this before a rescuer makes an attempt. Self-administering the manoeuvre is also a clear signal to rescuers (compared with clutching one’s throat, which might be misinterpreted as distress due to another cause such as a heart attack). A novel finding is that self-administered thrusts over the back of a chair generated greater pressures than operator-delivered thrusts or self-administered ones. Most food is consumed seated, so there is likely to be a chair available when choking occurs.

Obesity
No obese subjects were included in this study, median BMI 25.9 (25–26) kg/m².

Obesity may affect abdominal thrust outcome as anatomical landmarks for hand positioning may be variable and add to the difficulty of performing the manoeuvre around an increased abdominal circumference. A higher percentage of abdominal adipose tissue may have a dissipating effect on the force applied with abdominal thrust manoeuvres and therefore lessen their effectiveness.

CONCLUSION
The key to diagnosing complete airway obstruction is a conscious subject, in the process of eating, who is unable to breathe at all, nor to speak. Autoadministered thrusts appear as physiologically effective as first-aider-administered ones to generate expulsive intrathoracic pressures, and chair thrusts appear to be the most physiologically effective. We advise that everyone with complete airway obstruction should, in the first instance, either autoadminister abdominal thrusts or perform a chair thrust. The various manoeuvres should be more widely taught in schools, first aid courses, to staff in restaurants and publicised as widely as possible. We would like to see suitable notices in eating places.

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