THE USE OF AN INFLATABLE CUIRASS IN ENDOSCOPY

by

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To share the patient's airway with the surgeon, in the absence of an endotracheal tube, often presents the anaesthetist with additions to the normal problem, in such circumstances, of adequate pulmonary ventilation. In no cases is this more evident than during laryngoscopy or bronchoscopy under general anaesthesia. Complete relaxation with really quiet breathing may not be difficult to obtain, but it is far from easy to maintain this state if the examination is continued for some time. The combined use of thiopentone and suxamethonium, after local analgesia has been instituted in the larynx and trachea, provides excellent conditions for these examinations. Intermittent injections of either drug may be required if the procedure is prolonged, and fluctuations may occur in the patient's condition. The uneven anaesthesia results in the species of "intermittent bronchoscopy" already deprecated by Macintosh (1954). It causes also interruptions in the surgeon's work and anxiety to the anaesthetist.

Various methods of overcoming the problem of ventilation and oxygenation have been described in recent years. Churchill-Davidson (1952a) described the occasional insufflation of oxygen down the bronchoscope after insertion into its lumen of a close-fitting Magill's tube, and repeated the advice at a later date (1952b) when he had employed suxamethonium instead of gallamine triethiodide as the relaxing agent. Macintosh (1954), already quoted, called in the help of topical analgesia. Cheatle and Chambers (1955) described the use of a fine Portex tube passed into the trachea alongside the bronchoscope. Through this fine tube oxygen was delivered during the anaesthesia and their paper includes figures for $pO_2$ and $pCO_2$ in the blood. Buck (1955) wrote confirming this technique and stressing the importance of high flow rates to avoid CO$_2$ accumulation. The earliest available reference to the use of a respirator in anaesthesia for bronchoscopy was found in an article by Toker (1955). He reported the use of a Kifa respirator applied to the chest, after the patient had been anaesthetized with thiopentone and relaxed to apnoea with suxamethonium.

The application of a cuirass respirator for endoscopy has also been described by Green and Coleman (1955) and by Bayuk (1955). These observers stress the value of such an apparatus for maintenance of ventilation during anaesthesia and relaxation. In the former report a negative pressure cuirass respirator of the Monaghan type was employed. This consists of a pump unit, twelve graded sizes of chest shells and possibly a battery. The apparatus used by Bayuk was an Emerson chest respirator and includes also a selection of shells for application to the chest.

The use of a cuirass to produce adequate movement in the chest thus seems to offer a satisfactory solution to the problem encountered in endoscopy. The apparatus described in the papers mentioned is mildly elaborate and includes an expensive machine. The inflatable cuirass described here is exceedingly simple, quite inexpensive and has proved very efficient on the occasions when it has been in use. Its construction is based on the sphygmonanometer cuff—an enlarged rubber bag is enclosed in a light cover to which are sewn two web straps with appropriate buckles which allow of a certain amount of adjustment to fit the patient's chest. The cuff extends from a little below the nipple line to a few inches below the xiphisternum, and from the posterior axillary line on one side to the same line on the other when it is applied to the front of the chest in an average adult. Two or three different sizes have been made and these can be adjusted to fit adequately on.
patients varying from a small child to a large and bulky adult. From the lower side of the cuff, a wide bore, short rubber tube projects. It is braced with a metal sleeve into which fits the facepiece mount of a Boyle's anaesthetic apparatus. The back of the cuirass is a simple rectangle of rubber and light canvas from which the web straps extend. The photographs reproduced here show clearly the construction of the cuirass (fig. 1) and its application to the chest and attachment to the Boyle's machine (fig. 2).

It is desirable to produce a mildly sedated patient who can be readily translated into a light, controllable plane of anaesthesia—who will be fully relaxed during endoscopy, and who will quickly regain a return of reflexes and even consciousness at the close of the procedure. Adequate oxygenation must be ensured during apnoea or shallow breathing, but as these examinations are usually comparatively brief, development of respiratory acidosis can be largely ignored.

**TECHNIQUE**

The patient is premedicated with atropine sulphate 0.6 mg and papaveretum 20 mg one hour before the time chosen for the examination. On arrival in the theatre, the patient is placed upon the operating table and the inflatable cuirass is adjusted on the chest. It should be strapped in position firmly but not tightly and should give the patient a feeling of support. The upper border should lie below the nipple line and the lower border a few inches below the xiphisternum. From side to side it should extend from the posterior axillary line on one side to the same point on the other. Varying sizes of patients make it impossible to achieve this position exactly, of course, but the different sizes of cuirass will allow of an adequate approximation in each instance. It is suggested that the method is applicable to infants to whose chest can be applied an ordinary sphygmomanometer cuff.

Anaesthesia is now induced with thiopentone (maximum initial dosage 500 mg) and this is followed by the intravenous injection of an appropriate dose of suxamethonium which has been diluted to a strength 100 mg in 10 ml of sterile water. Such a dilution allows of a more accurate estimate of dosage and may help to diminish the postoperative muscular pains of which many patients complain after the use of this drug. Whenever relaxation supervenes, a few inhalations of oxygen are given by application of a facepiece and manual pressure on the rebreathing bag of a Boyle's apparatus. If the larynx and trachea have not been prepared with a topical analgesic beforehand, they are now sprayed under direct vision.
with 4 per cent lignocaine with adrenaline and the surgeon can begin his examination on a fully relaxed patient. The topical analgesia is valuable in diminishing reflex responses, and in the prevention of such responses at the close of the procedure when the bronchoscope or laryngoscope is withdrawn.

Immediately following the inflation of the lungs with oxygen, the facepiece is removed and its mount is now attached to the sleeve in the rubber tube connected to the cuirass. The cuirass and rebreathing bag are filled from the apparatus to a comfortable tightness, the gases are shut off, and firm manual intermittent pressure on the rebreathing bag will produce the necessary rhythmic inflation and deflation of the cuirass with a corresponding effect on the chest. A separate small flow of oxygen (5 or 6 litres per minute) is now led into the aspirating tube of the bronchoscope and the movement of this oxygen in the depths of the bronchial tree will maintain the patient in the desirable pink colour of adequate oxygenation. In laryngoscopy, the oxygen is similarly led to the back of the nasopharynx by means of a fine nasal endotracheal tube which has been cut appropriately short. Figure 3 shows the result of a continuous estimation of oxygen saturation of the blood carried out on a patient undergoing a bronchoscopic examination which lasted for 25 minutes from the time of induction until the completion of the procedure. It can be seen that there was a fall to 80 per cent momentarily during induction and to 82 per cent while the bronchoscope was deeply situated for a short period in the left main bronchus. During the rest of the examination $O_2$ saturation remained at or above 90 per cent.

Following the injection of the initial dose of suxamethonium, the needle is maintained in the vein and supplementary doses of this drug or of thiopentone can be given. The return of respiration can be readily appreciated by the hand holding the rebreathing bag. It is only occasionally necessary in longer examinations to supplement the initial dose of thiopentone. The use of a Gordh or Mitchell needle is an acceptable refinement.

At the close of the examination or biopsy, the airway is aspirated, the endoscopic instrument withdrawn and the patient is usually now breathing spontaneously and only lightly asleep. Reversion to the facepiece or continuation for a few moments with the cuirass will control the patient whose ventilation is considered to be still inadequate.

**RESULTS**

The method has now been used very successfully in 30 cases which include 15 laryngoscopies and 15 bronchoscopies. The ages of the patients range from 6 to 67 years and have included heavy robust types as well as frail and delicate subjects. In only two cases has complete success not been achieved. This was due entirely to a failure to fit the cuirass properly to the chest in especially the very adipose female with bulky breasts. The fatty tissue appeared to cushion the effects of the cuirass which should clearly have been applied below them at a lower level.

The duration of the examinations has varied from a minute or two up to fifteen or twenty minutes and the patients have been maintained in full relaxation, largely apnoeic and well oxygenated throughout. Two cases might be briefly cited as illustrative of the benefits conferred.

1. **Male (47)**. Large, 16 stone (101 kg); large teeth, massive jaw; biopsy of vocal cord tumour; duration 15 minutes; thiopentone 850 mg; suxamethonium 180 mg. This case would have been impossible without full relaxation and in the event, he gave no trouble at all.

2. **Male (58)**. Emphysematous; bronchoscopy; previously failed on account of spasm and cyanosis. Completed successfully with aid of the cuirass at a second attempt.
DISCUSSION

The use of this simple device has removed almost all the anxiety from anaesthesia for endoscopy. The patient can be maintained for considerable periods in an adequate state of oxygenation and no apprehension felt about further dosage of the relaxant drug. The surgeon can begin and continue his examination under optimal conditions without the previous tiresome wait for the patient to begin breathing again after the injection of suxamethonium—meanwhile the peak of the relaxation period was passing him by. The equipment is simple, effective and inexpensive and is operated by a Boyle’s apparatus which is universally available.

SUMMARY

A simple inflatable cuirass for use in maintaining ventilation during apnoea and relaxation under general anaesthesia for endoscopy has been described. A detailed account of its method of use is included.

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REFERENCES