A HIDDEN FAULT IN CUFFED TUBES

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SUMMARY

A hidden fault arising during the manufacture of the inflating tubes of some endotracheal and tracheostomy tubes is described. The complications which may arise from this fault are enumerated, and some of these are illustrated by case reports. A description is given of the slight modification of manufacturing technique which has been made to eliminate this fault.

Faults in anaesthetic apparatus are not uncommon, and in most cases are due to poor maintenance of well made equipment. Faults can also arise, however, at the stage of manufacture. Such defects may escape detection by the most thorough anaesthetist, revealing themselves as some mystifying or even tragic complication.

The final link with the patient is often an endotracheal tube, and this slender link is all too easily weakened by small errors in manufacture. Bubble formation associated with the cuffs of latex, flexometallic endotracheal tubes has been described by Davies (1963), and Burns (1956) reported a case of respiratory obstruction due to bubbles in the walls of the same type of tube; incorrect labelling of the pilot balloons of a cuffed double-lumen endobronchial tube was described by Jenkins (1963); a fatality resulted from the use of a metal endotracheal connector with a complete metal septum which had not been drilled out (Macintosh, personal communication).

There are several ways of making pilot balloons and their inflating tubes. In some the inflating tube on its way to the cuff passes uninterrupted through the pilot balloon; the balloon is inflated by two holes cut in the inflating tube. These holes should be cut at 180 degrees from each other; thus if one hole is occluded by bending the tubing, the other is stretched more widely open.

Since the openings in the inflating tube are cut by hand with scissors, they may be made as slits rather than circular apertures, or they may be cut almost on the same aspect of the tube instead of opposite each other. In either case certain positions of the tube may result in the openings becoming closed. The cuff is thus isolated and can be over-inflated without the pilot balloon giving warning; this may lead to rupture of the cuff, herniation over the end of the endotracheal tube, or forcing of the bevel of the tube against the tracheal wall, with consequent occlusion. Alternatively, the cuff may collapse while the pilot balloon remains inflated; this would be disastrous in the presence of blood, vomit or secretions in the upper airway. Over-inflation of the cuff will not occur if only enough air is put in to prevent leakage of gas on gently squeezing the reservoir bag. However, if the pilot balloon does not inflate, it is usually assumed that the cuff has become defective, and more air may be blown in without the usual precaution of squeezing the bag. Trouble will then arise if some valvular device is used to inflate the cuff and is left attached, for example, the Mitchell cuff inflator or the Vellacott valve.

CASE 1. A 54-year-old woman was intubated with a previously tested No. 8 cuffed Oxford endotracheal tube. On squeezing a Mitchell endotracheal cuff inflator attached to the inflating tube there was a delay of about 1 second before the pilot balloon inflated. The inflator was removed, and then reattached and used again: this time several squeezes produced no inflation of the pilot balloon. It was assumed that the cuff had become perforated, but as there was no great need for an inflated cuff, the tube was left in position with the Mitchell inflator attached. Maintenance of anaesthesia with nitrous oxide, oxygen and trichloroethylene seemed satisfactory apart from a persistent expiratory wheeze. This “bronchospasm” remained in spite of a change from trichloroethylene to halothane. A mechanical cause for the obstruction then being suspected, the Mitchell cuff inflator was removed, and the “bronchospasm” vanished at once.
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The endotracheal tube is shown in figure 1. The inflating tube within the pilot balloon, shown enlarged in figure 2, had slit-like openings placed fairly near the same side of the tube. The corresponding portion of a normal inflating tube is shown in figure 3. The cuff had been inflated in the first instance with only a delayed escape of air into the pilot balloon, and on the second occasion without any inflation of the pilot balloon. On the second occasion the cuff had been over-inflated, and the “bronchospasm” was probably due to its partial herniation over the end of the tube.

Case 2. Intubation had been carried out as in Case 1. On inflation of the endotracheal cuff there was again a momentary delay before the pilot balloon inflated. The significance of this now being known, the endotracheal tube was replaced by another. On examination, the openings in the inflation tube were again found to be slit-like.

Case 3. Tracheostomy was being performed on a 12-year-old-boy. A Radcliffe cuffed tracheostomy tube was inserted, but several vigorous puffs with a Mitchell cuff inflator failed to inflate the pilot balloon even after it had been rubbed between the thumb and forefinger. This at first seemed to indicate a perforated cuff, although the tracheostomy tube had been tested before sterilization. The anaesthetist, suspecting the true cause of the trouble, removed the tube and inserted another. The offending tube was found to have a normal cuff, but the slits within the pilot balloon were the narrowest yet found (fig. 4), and it was virtually impossible to inflate this pilot balloon. When wetted by boiling, additional adhesion caused by surface tension had prevented the slits from opening even with the vigorous methods used.

**DISCUSSION**

After sterilization by boiling, the pilot balloon of an endotracheal tube sometimes shows unwillingness to inflate. A rub with finger and thumb usually overcomes this difficulty, which is often attributed to adhesion of the internal wet surfaces of the pilot balloon. It seems likely that persistent failure to inflate is sometimes due to faulty manufacture of the inflating tube.
The fact that in the three cases here discussed the endotracheal tubes were of the Oxford pattern, and the tracheostomy tube a Radcliffe one, merely indicates the preference for these tubes in Oxford; some cuffed Magill tubes are made in the same way and may show the same defect.

It is important to emphasize that the fault referred to in this paper can occur only when the inflating tube runs continuously through the pilot balloon. The manufacturer who employs this design is now introducing a metal director, with a transverse notch, into the inflating tube while the rubber is still uncured. A knife cut is made on to the groove, thus ensuring the removal of a piece of rubber. The resulting hole is too large to be occluded by bending the inflating tube, and a second hole is not made, being both unnecessary and likely to weaken the inflating tube too much. These modified tubes can easily be identified, as the large hole can be felt through the pilot balloon. Inevitably, cuffed tubes of the former type will remain in use for some time, so that whenever an inflating tube without a large hole can be felt passing continuously through the pilot balloon the possibility of the complication described in this paper should be borne in mind.

ACKNOWLEDGMENTS
I am grateful to the several firms who supplied details of the manufacture of their tubes, to Mr. I. W. Roberts who took the photographs, and to Dr. J. Parkhouse for his advice and interest.

REFERENCES