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Pattern of breathing during upper gastrointestinal endoscopy: implications for administration of supplemental oxygen

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SUMMARY

Cardiopulmonary complications account for half the deaths associated with upper gastrointestinal endoscopy. The incidence of hypoxia at the time of upper gastrointestinal endoscopy can be greatly reduced by the administration of supplemental oxygen via nasal cannulae. Using dual thermistors in the mouth and nostrils of patients undergoing upper gastrointestinal endoscopy, the present study demonstrates that most patients breathe predominantly via the oral, rather than the nasal, route following intubation of the oesophagus. The implication from the study is that, if supplemental oxygen is to be used in 'at risk' patients, it would be logical to employ an oral, rather than nasal, route of administration.

INTRODUCTION

Cardiopulmonary complications account for over half the deaths associated with upper gastrointestinal endoscopy.[1–3] With the increasingly widespread use of pulse

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27-2

oximeters it has been apparent that oxygen desaturation occurs not infrequently at the time of gastrointestinal endoscopy.[1,3] Cardiac arrhythmias are observed to occur particularly frequently when the patient becomes hypoxic.[1–3] Optimizing arterial oxygen saturation and rapidly detecting desaturation ought to minimize the risk of myocardial ischaemia. We reported in 1987[4] that supplemental oxygen delivered via nasal cannulae at a rate of 2 L/min greatly reduced the incidence of hypoxaemia during gastroscopy. This observation[4] has been confirmed[5–10] but even when nasal oxygen is delivered at 3 or 4 L/min[7] some patients' oxygen saturations have been observed to fall well below 90% at certain stages of the examination.[7]

It had been our clinical impression that many patients appeared to breathe through the mouth, rather than nose, during upper gastrointestinal endoscopy. If this is the case then it might be more logical to give 'at risk' patients supplemental oxygen via the mouth. The purpose of the present study was to use a dual thermistor approach to examine patients breathing patterns both before and during endoscopy.

MATERIALS AND METHODS

Thermistor study

A total of 39 patients was studied. Ventilation through the nose was measured using two thermistors (4.7 k GM 472, supplied by R. S. Components, Corby, Northants, UK.) One of these was mounted in each prong of an Argyle Oxygen Cannula. The summed output from these thermistors was directed to one channel of a chart recorder (LS 52 Recorder, supplied by Linseis UK, Duxford, Cambridge). A third thermistor was located inside a standard gastroscopy mouth piece and connected to the second channel of the recorder. We were, thus, able to observe the patterns of ventilation with respect to the relative contributions of nasal and mouth breathing. Breathing was then classified as being, (a) exclusively through the nose, (b) exclusively via the mouth, or (c) using a combination of both the nose and mouth.

The patient's oxygen saturation was also continuously recorded on the third channel of the pen recorder. After a baseline period of observation with both thermistors in place, the patients were sedated with intravenous midazolam. When judged to be suitably sedated the patients were endoscoped by one of us (G. D. B.), using a direct vision method of intubating the upper oesophagus. An event button was pressed to indicate on the pen recorder the exact timing of the intravenous sedative, the start and end of the intubation of the oesophagus and the total time the patient had the endoscope *in situ*. The pre- and post-intubation traces of each of the 39 patients were compared.

RESULTS

Dual thermistor study

In the pre-intubation baseline period, the majority of patients appeared to be breathing either exclusively through the nose or via a mixture of nose and mouth (see Table 1). As can be seen from Figures 1 and 2, the patterns of breathing changed dramatically as soon as the endoscope was passed into the oesophagus. All but one patient either breathed exclusively via the mouth or via a combination of the mouth and nose. The change of breathing pattern from pre- to post-intubation shown in Table 1 is highly significant (χ^2 test 24.06, $P < 0.001$). The overall change in breathing pattern noted after passage of the endoscope is summarized in Table 2 where it can be seen that 30/39 (76.9%) had a detectable increase in mouth breathing, compared with only 1/39 (2.6%) in which nasal breathing appeared to be increased. In 22/39 (56.4%) nose breathing was noted to decrease after intubation of the oesophagus, whereas, in contrast, in no patient was mouth breathing actually decreased after the endoscope had been passed.

Table 1. Dual thermistor study. Breathing pattern before and after passage of the gastroscope.

	Number	Percentage
Pre-intubation		
Mouth only	1	2.6%
Mouth and nose	21	53.8%
Nose only	17	43.6%
Total	39	100.0%
Post-intubation		
Mouth only	12	30.8%
Mouth and nose	26	66.6%
Nose only	1	2.6%
Total	39	100.0%

Table 2. Dual thermistor study. Change in breathing pattern noted after passage of the gastroscope

	Number	Percentage
Increased mouth breathing	30/39	76.9
Decreased mouth breathing	0/39	0.0
Increased nose breathing	1/39	2.6
Decreased nose breathing	22/39	56.4
Increased mouth and decreased nose	18/39	46.2

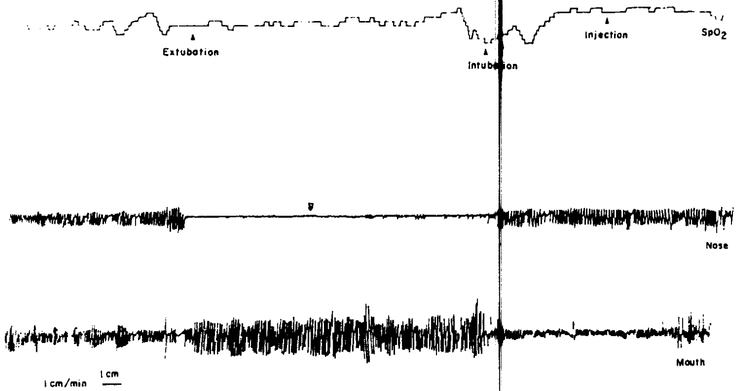

Figure 1. Triple channel recording reading from right to left of oxygen saturation (Sp O_2), measured with a pulse oximeter, plus patient's breathing pattern simultaneously studied using thermistors in the nostrils and a modified endoscopy mouthpiece (see text for details). It can be seen that the patient was breathing predominantly through the nose until the gastroscope entered the upper oesophagus. The patient then switched to breathing almost exclusively through the mouth with very little nasal breathing, until the gastroscope was removed. At this stage the patient demonstrated a combination of oral and nasal breathing.

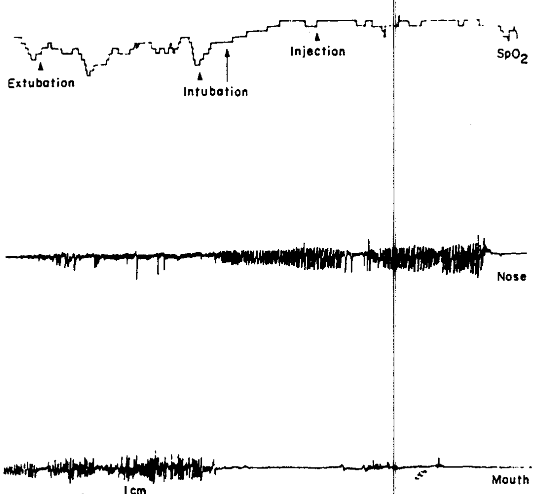

Figure 2. A further example of a patient's dual thermistor breathing study with the patient switching from a predominantly nasal route of ventilation to predominantly mouth breathing following the passage of the gastroscope (please see text for details).

DISCUSSION

To our knowledge, this is the first study of its type using a dual thermistor approach to observe patients' breathing patterns during upper gastrointestinal endoscopy. Although the two thermistors, one in the nostril and the other in the mouth, were uncalibrated, they were able to give useful qualitative data. Within a single patient a major rise in a thermistor's output indicates increased air flow over it. This probably represents increased breathing via that route, although the increased signal may have resulted from other factors—for example, a narrower air channel due to partial occlusion of the mouth piece by the endoscope.

It can be seen from Tables 1 and 2, as well as Figures 1 and 2, that there is a major change in most patients' breathing patterns once the oesophagus is intubated. The majority switched from a mixed mouth and nose, or pure nasal breathing pattern, to either pure oral or a predominantly oral pattern. In 30/39 (76.9%) we observed an increase in the percentage of mouth breathing after intubation, compared with only 1/39 (2.6%) in the case of the nose.

The implication of this study is that, if supplemental oxygen is to be given to 'at risk' patients undergoing upper gastrointestinal endoscopy, oral, rather than nasal, administration might be more logical.

In a recent study, 51.3% of control patients sedated with a diazepam and pethidine combination prior to E.R.C.P. had falls in their oxygen saturation to below 90% for more than 60 seconds.[7] The group given intra-nasal oxygen (4 L/min) had a 9.8% incidence of a similar level of oxygen desaturation. Our preliminary results would suggest that if these workers had used oral, rather than intra-nasal supplemental oxygen, they might have reduced the incidence of potentially serious hypoxia still further.

Cardiopulmonary complications account for over half of the deaths associated with upper gastrointestinal endoscopy.[1] Hypoxia during the procedure is now recognized to be common.[2,3] Cardiac arrhythmias are particularly likely to be noted at times of oxygen desaturation. In the E.R.C.P. study mentioned above,[7] those patients with oxygen saturation below 90% had a significantly higher pulse rate than those who were not hypoxic. Myocardial oxygen demand rises with heart rate, and this necessitates an increase in coronary blood flow as the myocardium normally extracts a maximum of 65% of available oxygen. Seventy per cent of coronary blood flow occurs during diastole, which is shortened by tachycardia. Individuals with non-compliant coronary vessels due to atheroma are at risk of myocardial ischaemia during tachycardia as oxygen demand rises while oxygen perfusion falls and tissue extraction is already maximal.

Because the myocardium cannot extract more than 65% of oxygen carried by the blood, a fall in saturation from 100 to 90% actually represents a 15% reduction in available oxygen.[7] Optimizing arterial oxygen saturation using supplemental oxygen, and rapidly detecting desaturation with the aid of a pulse oximeter, should minimize the risk of myocardial ischaemia. We are conducting a randomized prospective study to compare the efficacy of oral versus intra-nasal oxygen as a means of preventing significant hypoxia during upper gastrointestinal endoscopy.

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