likely that inadequate control of renal failure was responsible for the deterioration in nerve conduction.

Anorexia at the onset of hepatitis was a feature in all patients. An adequate caloric intake was maintained, however, and vitamin supplements were continued. Half the patients had no overt protein imbalance and in the others protein loss was of a minor degree. It is therefore unlikely that protein loss or malnutrition was responsible for changes in nerve conduction.

Drug absorption and metabolism are impaired in both renal and hepatic failure. No patient received any preparation known to be neurotoxic when given to people with normal renal and hepatic function.

Previous reports of hepatitis in dialysis units have not mentioned impaired peripheral nerve function (Jones *et al.*, 1967; Eastwood *et al.*, 1968; London *et al.*, 1969), but our results suggest that the two are closely linked.

Klippel and Lhermitte (1908) noted that "catarrhal infective jaundice can be complicated by a more or less generalized polyneuritis." They thought that the polyneuritis was due to the infective agent responsible for the jaundice and was not dependent on hepatic insufficiency. Lelong and Bernard (1935) reported the case of a 14-year-old girl who developed hepatitis and a predominantly motor neuropathy which improved after two months. Peripheral neuropathy has also been described in the accounts of hepatitis occurring during the second world war (Brain, 1942-3; Lescher, 1944; Byrne and Taylor, 1945; Lovell, 1945). More recent clinical and pathological observations show that a demyelinating peripheral neuropathy occurs in chronic hepatic disease (Dayan and Williams, 1967; Ortiz Vázquez *et al.*, 1967).

Conduction in peripheral nerves can be impaired both by viral infections and by hepatic parenchymal insufficiency. The virus can exert its effect either by damaging the cell body directly, as in poliomyelitis (polioclastic), or by exciting an abnormal immune response detrimental to neural tissue. The neurological lesion might be polioclastic. The relatively minor impairment of conduction velocity would be consistent with such a pathological process.

It is possible that an immunological response to a viral infection could give rise to segmental demyelination of the peripheral nerves. The reduction in nerve conduction velocities in our study was not as pronounced as is usually found associated

with widespread segmental demyelination (Gilliat, 1966). However, the improvement after recovery from hepatitis suggests that demyelination, with subsequent remyelination, may be partly responsible for the neural changes.

Hepatic parenchymal insufficiency could damage peripheral nerves by producing unfavourable metabolic disturbances. Dayan and Williams (1967) suggested that the predominantly demyelinating peripheral neuropathy associated with chronic hepatic failure might be related to disordered insulin metabolism. Profound hypoglycaemia, though known to occur in acute hepatic necrosis, was not observed in our patients. Alterations of insulin metabolism or other metabolic pathways remain possible factors in the aetiology of the impaired neural conduction.

The interpretation of the changes in nerve conduction velocity is complicated by the pre-existing impairment of conduction associated with chronic renal failure. Our observations show a deterioration in neural conduction in patients suffering from serum hepatitis but the pathogenesis of this change is not clear.

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Observations on Cardiac Arrhythmias during Laparoscopy

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British Medical Journal, 1972, **1**, 411-413

Summary

The incidence of cardiac arrhythmias occurring during laparoscopy was studied in 100 consecutive patients who received carbon dioxide to inflate the abdomen and compared with that in 45 patients in whom nitrous oxide was substituted for carbon dioxide. Seventeen patients receiving carbon dioxide and two receiving nitrous oxide developed multiple arrhythmias, the commonest variety being fusion beats due to ventricular ectopic beats. Blood gas determinations showed that carbon dioxide caused a significantly higher level of Paco_2 and a lower pH than did nitrous oxide.

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Introduction

The operation of laparoscopy has recently achieved popularity in gynaecological surgery. Since 1966, in the Edinburgh Royal Infirmary, the number of such operations has been increasing annually, and currently more than 1,000 are performed per year, most being for sterilization.

Cardiac arrhythmias are a fairly common occurrence during the procedure (Scott, 1970), presumably because it is impossible to prevent a degree of hypercarbia (especially if the respiration is spontaneous) when carbon dioxide is used to inflate the abdomen. Thus if halothane is being administered arrhythmias are to be expected in a proportion of cases. It might be possible, therefore, to limit the rise in Paco_2 during insufflation, and thereby reduce the incidence of arrhythmias, if nitrous oxide were used in the place of carbon dioxide as the insufflating gas.

The present study was undertaken for the following purposes: (a) to assess the incidence of cardiac arrhythmias during laparoscopy and to determine the types of arrhythmia occurring, and

(b) to determine the degree of hypercarbia developing when carbon dioxide is used to produce pneumoperitoneum and compare it with that found when nitrous oxide is substituted.

Methods

Anaesthesia.—Patients received atropine 0.6 mg intramuscularly one hour before operation. Anaesthesia was induced with thiopentone 500 mg to which 60 mg of gallamine was added and was maintained with nitrous oxide and oxygen (3:1 litres per minute in a semiclosed system with absorber) and halothane 2%. Gallamine was considered useful as it helped to smooth induction and produce a moderate degree of abdominal relaxation, thus assisting with the initial distension of the abdomen with gas. Respiration was spontaneous throughout except for a few patients who required assistance during the first few minutes. Gallamine in this dosage seemed to have little effect on respiration, which invariably responded to hypercarbia when it occurred. Neostigmine was not required at the end of the operation. Endotracheal intubation was not performed, a face-mask being used in all cases. No patient regurgitated, experience over the past five years indicating that this complication occurs no more frequently than with other minor gynaecological operations.

Blood Gases.— P_{aCO_2} and pH were determined from capillary blood by means of the Astrup apparatus. A series of 12 patients who received carbon dioxide insufflation of the abdomen were compared with 12 in whom nitrous oxide was used. Blood was taken just before peritoneal insufflation and just before deflation of the abdomen.

Electrocardiography.—After some considerable experience with electrocardiography for this operation it was decided to use an oesophageal lead as we found it difficult consistently to obtain satisfactory recordings of the P wave with standard or precordial leads. This problem is overcome by an oesophageal lead which, being immediately behind the right atrium, gives large and unmistakable P waves (Fig. 1). The lead consisted of a small smooth wire loop protruding from a plastic catheter

FIG. 1—E.C.G. trace using an oesophageal lead to show the P wave.

of 2 mm external diameter. It was positioned by reference to the E.C.G., the position giving the largest P wave and smallest respiratory baseline swing being chosen. The E.C.G. was monitored throughout on an oscilloscope by a trained cardiologist. If an arrhythmia appeared a tape-recording was taken until either it disappeared or the operation ended. Single or very infrequent arrhythmias were ignored, but, in fact, the great majority that occurred were multiple and lasted longer than one minute. The tape-recordings were subsequently written out and interpreted by one of us (D.G.J.). In all, 100 consecutive patients receiving carbon dioxide insufflation had continuous E.C.G. monitoring, and these were compared with a

series of 45 consecutive cases in which nitrous oxide was substituted for the carbon dioxide. The two series were compared in regard to blood gas changes by "Student's" t test and in regard to the frequency of arrhythmia by the χ^2 test.

Results

Cardiac Arrhythmias.—These occurred in 17 of the 100 consecutive cases in which carbon dioxide was used to inflate the abdomen. Fifteen of the 17 arrhythmias were of the same type, of which we can find no previous account during anaesthesia. They consisted of ventricular extrasystoles occurring after the P wave and thus involving fusion with the normally conducted impulse (Figs. 2 and 3). The other two arrhythmias were

FIGS. 2 and 3—E.C.G. traces showing a control strip and a strip during an arrhythmia occurring during laparoscopy.

multiple ventricular ectopic beats. Of the 45 patients who received nitrous oxide to inflate the abdomen only two developed arrhythmia, both being the same type of fusion beats as described above. The lower incidence seen with nitrous oxide is statistically significant ($P < 0.01$).

Blood Gases.—When carbon dioxide was used as the insufflating gas P_{aCO_2} rose on average from 43.2 to 60.8 mm Hg.

Mean Values $\pm$ S.D. of P_{aCO_2} , pH, and Duration of Insufflation in 12 Cases Receiving Carbon Dioxide and 12 Cases Receiving Nitrous Oxide

	Carbon Dioxide		Nitrous Oxide		t	P
	Before	During	Before	During		
P_{aCO_2} mm Hg	43.2 $\pm$ 4.88	60.8 $\pm$ 10.89	44.6 $\pm$ 4.14	50.5 $\pm$ 6.11		
pH	7.33 $\pm$ 0.02	7.25 $\pm$ 0.04	7.31 $\pm$ 0.02	7.29 $\pm$ 0.03		
Rise in P_{aCO_2}	17.58 $\pm$ 10.04		5.92 $\pm$ 4.36		3.69	<0.01
Fall in pH	0.08 $\pm$ 0.04		0.03 $\pm$ 0.02		3.88	<0.01
Duration of insufflation	8.55 min $\pm$ 2.42		9.7 min $\pm$ 2.53			

When nitrous oxide was substituted Paco_2 rose from 44.6 to 50.5 mm Hg. This difference is statistically significant ($P < 0.01$). Full details of the blood gas changes are shown in the Table.

Discussion

Cardiac arrhythmias are a common occurrence during laparoscopy, especially when carbon dioxide is used to inflate the peritoneal cavity. These arrhythmias are almost certainly related to the high Paco_2 in conjunction with the use of halothane, but they may occasionally be due to reflex activity from the distending abdomen. They are sometimes seen when the Paco_2 is relatively low. There is little evidence, however, that these arrhythmias are harmful to the patient. The fear that they may progress to ventricular fibrillation or cardiac arrest would seem groundless in view of the large number of these operations which have been carried out (more than 4,000 in this area) without incident. We are aware that cases of cardiac arrest have occurred (Scott, 1970) but it would seem that these are due to carbon dioxide embolus resulting from accidental insertion of the Verrés needle into the pregnant uterus, no pressure-limiting device having been used during insufflation.

The arrhythmias most commonly seen in this series were fusion beats occurring after the P waves and causing bigeminy. This arrhythmia is often impossible to diagnose by palpation of the radial pulse as the extrasystoles occur only fractionally before the expected normally conducted beat. Little or no haemodynamic disadvantage is likely to accrue from this arrhythmia. Alexander (1971) described "nodal" arrhythmias during oral surgery which may be identical with those observed by us, but we would not consider them to be supraventricular.

Carbon dioxide has been chosen as the gas for peritoneal insufflation because of its high solubility. This ensures the rapid absorption of any remaining gas postoperatively and gives a degree of safety if, by mischance, the gas is injected intravascularly. However, nitrous oxide has advantages over carbon dioxide for this purpose. Cardiac arrhythmias are much less frequent and the respiratory drive is less pronounced owing to the lower Paco_2 that is produced. Our results indicate that the major cause of a rise in Paco_2 when carbon dioxide is used is due to absorption from the peritoneal surface. The splinting of the diaphragm which undoubtedly occurs is responsible for about 25 to 30% of the rise and, of course, still occurs if nitrous oxide is used. Nitrous oxide has a high solubility in plasma (68% of that of carbon dioxide) and the residual gas left in the abdomen will disappear quickly. It does support combustion, but as there is no question of the diathermy setting fire to the abdominal contents this is of no importance. Reduced respiratory drive compared with that seen with carbon dioxide gives a quieter field for the surgeon. Several hundred laparoscopies have now been carried out with nitrous oxide in this way without untoward incidents.

We wish to thank Professor R. J. Kellar for allowing us to study his patients. Miss E. McLachlan, Mr. A. McKinnon, and Mr. T. McFetters gave invaluable technical help. We are especially grateful to Dr. H. L. Marriott, St. Petersburg, Florida, U.S.A., and Professor Schamroth, Witwatersrand University, South Africa, for their valued opinions regarding the E.C.G. tracings.

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Role of Venous Needle Hub in Extracorporeal Pressure Changes during Haemodialysis

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British Medical Journal, 1972, 1, 413-415

Summary

Certain types of stainless steel needles with metal hubs, and also a fistula set with projecting internal edges, were used at the venous end of the haemodialysis circuit and found to be associated with undesirable rises in extracorporeal pressure in 56 to 64% of dialyses. These increases in pressure are likely to be the result of platelet thrombus formation at the hub of the needle brought about by turbulent flow. The use of a plastic cannula and a stainless steel needle with a plastic hub, both of which have smooth internal surfaces, resulted in increases in pressure in only 4 to 12% of dialyses.

Introduction

Wide fluctuations of pressure in the extracorporeal system have been observed during maintenance haemodialysis. Such pressure

increases inadvertently promote ultrafiltration and can result in the uncontrolled removal of extracellular fluid. Our findings suggest that the properties of the venous needle hub may significantly influence the incidence of pressure increases.

Method

Five 14 gauge needle assemblies were tested (Fig. 1). The first (alloy) was the Bardic needle (No. 1614 EPS—alloy) with an aluminium alloy hub. The second (alloy-modified) was basically the first needle altered locally so as to create a smooth internal incline at the hub. The third (plastic hub) was the Bardic plastic hub needle (No. 1614 EPS—plastic). The fourth (fistula set) was the Travenol arteriovenous fistula set (No. AKM0276), which has a shaft set into a plastic (nylon) hub attached to plastic tubing (approximately 34 cm long and 2.8 mm internal diameter). The thin-walled stainless steel shafts of the needles were all siliconized. The fifth assembly (cannula) was the 14 gauge Argyle Medicut, which has an extruded polypropylene cannula with partly siliconized, smoothly-curving luminal contours between tip and base, there being no sharply demarcated hub. Although all five needle assemblies were nominally 14 gauge, indicating that the external diameters of the shafts

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