POLYCYthaEMIC HYPOXaEMIA AND GENERAL ANAESTHESIA

A Case Report

BY

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SUMMARY

A laparotomy under general anaesthesia was performed upon a patient with polycythæmia. The postoperative course was complicated by severe hypoxæmia which, it is suggested, was due to postoperative and polycythæmic pulmonary venous admixture. Reference is made to the potential reversibility of the latter, and recommendations are made for the management of such cases.

The association between an increased red cell mass, whatever the cause, and increased venous-to-arterial admixture is well known (Lillehei et al., 1958; Murray, 1965; Lertzman et al., 1964). Similarly, the frequent occurrence of hypoxæmia during the postoperative period has also been well established (Bjork and Hilty, 1954; Hood and Beall, 1958; Nunn and Payne, 1962; Conway and Payne, 1964). The possibility that the former might be aggravated by the latter, thus causing a dangerous degree of hypoxæmia has not hitherto been reported to our knowledge. The following is a case report of a patient, suffering from an erythrocytosis presumably secondary to a neoplastic disorder, whose postoperative course was critically complicated by the combined effects of the two mechanisms of venous admixture mentioned above.

CASE HISTORY

The patient was a 52-year-old Indian male weighing 45.4 kg. He was admitted to hospital on October 7, 1965, with a three-month history of epigastric pain, occasional vomiting and weight loss. On examination the abdomen was found to be moderately distended, visible peristalsis was observed in the epigastric region and there was generalized tenderness to palpation. The blood pressure was 210/120 mm Hg. No further abnormality was noted other than some cyanosis of the mucous membranes.

On admission, serum electrolytes were normal. The haemoglobin concentration was 22.2 g/100 ml, p.c.v. 61 per cent, and w.b.c. 16,000/cu.mm. X-ray of the chest revealed no abnormality but a film of the abdomen showed fluid levels in the right lumbar region and a distended loop of bowel below. A barium meal, performed two days after admission, and a cholecystogram, did not reveal any abnormality.

Due to an exacerbation in the severity of his symptoms he was subjected to laparotomy on December 7, 1965. Pethidine 50 mg and atropine 0.6 mg were given by intramuscular injection 1 hour before induction of anaesthesia. The anaesthetic management was as follows. Tubocurarine chloride 5 mg was given intravenously as a test dose and, as no undue sensitivity was observed, a further dose of 32 mg (0.7 mg/kg) was given followed by 250 mg of thiopentone. A cuffed endotracheal tube was passed and anaesthesia maintained with a Blease ventilator delivering 30 per cent oxygen and 70 per cent nitrous oxide through a non-rebreathing circuit at an expired minute volume of about 15 l./min. The operative procedure, which lasted 1 hour, revealed active duodenal ulceration and a hard mass in the head of the pancreas from which a biopsy was taken. The histological report was that of adenocarcinoma. A vagotomy and gastroenterostomy were performed. At the end of the operation curarization was reversed, following 5 minutes hyper-inflation with air, by the administration of neostigmine 5 mg preceded by atropine 1.2 mg. One of the authors (A.J.C.) was called to see the patient for the first time in the recovery ward within 15 minutes of reversal. The patient appeared to be disorientated with marked cyanosis and tachypnoea. No further abnormality was detected clinically in the respiratory or cardiovascular systems. The tidal volume measured with a Wright respirometer varied between 300 and 400 ml. The respiratory frequency was about 30 b.p.m. A Rochester needle was inserted percutaneously into the femoral artery and arterial blood sampled for blood gas and pH measurements. These results appear in table I, from which it is evident that a very severe degree of hypoxæmia was present. The results of various other investigations undertaken at this time are as follows: haemoglobin 18.0 g/100 ml; p.c.v. 52 per cent; w.b.c. 21,000/cu.mm; platelets 209,000/cu.mm.
Liver function tests, serum electrolytes and haemoglobin electrophoresis were all within normal limits, and a chest X-ray and electrocardiogram were also normal. Total blood volume, using albumen labelled with iodine 131 was 84 ml/kg, the plasma volume was 38 ml/kg, and the red cell mass was 46 ml/kg, confirming the diagnosis of polycythaemia.

In view of the arterial hypoxaemia, inspired gas mixture was enriched with sufficient oxygen to produce arterial oxygen tensions of about 100 mm Hg. The clinical conditions of the patient improved gradually over the next 2 days, after which no further improvement in \( P_{aO_2} \) was observed. Blood volume studies were repeated 1 week later, by a more precise method, using red blood cells labelled with \( Cr^{51} \). The blood volume was 82 ml/kg, plasma volume 38 ml/kg, and the red cell mass 44 ml/kg.

**DISCUSSION**

That arterial hypoxaemia can complicate the postoperative course of major surgery is an established fact. This would seem to be due to gaseous maldistribution (relative under-ventilation of a large proportion of alveoli) or to mixed venous blood perfusing pulmonary vessels which are completely inaccessible to pulmonary gas exchange, or a combination of both. Venous admixture amounting to as much as 25–30 per cent of total pulmonary blood flow has been observed postoperatively by some workers (Nunn and Payne, 1962).

Polycythaemia of any variety, in common with other medical conditions such as myocardial infarction (McNicol et al., 1965), pulmonary embolism (Jones and Goodwin, 1965) and congestive cardiac failure (Saunders, 1965), is similarly associated with hypoxaemia, which is quantitatively of the same order, and probably qualitatively similar to the postoperative variety. The author's patient had an alveolar-arterial oxygen gradient of about 500 mm Hg during efficient oxygen inhalation. This, in the absence of abnormal physical signs in the chest and with a normal chest radiograph could only have been due to blood flow through intrapulmonary arteriovenous anastomoses or to clinically and radiologically inapparent areas of atelectasis which remained perfused with mixed venous blood.

This gradient gradually diminished after the first 48 hours to between 300 and 350 mm Hg, which probably represented the effects of his polycythaemia. The additional gradient observed immediately postoperatively was, we believe, due to the superimposed postoperative shunt effect.

Reduction of the red cell mass in polycythaemic patients by venesection and myelo-suppressive therapy is known to reduce the alveolar-arterial gradient for oxygen (Lillehei et al., 1958). It would therefore seem wise to administer such treatment before elective surgery to all polycythaemic patients, excluding those widi erythrocytoses consequent upon pre-existing arterial hypoxaemia, such as Fallot's Tetralogy. This should help to minimize the degree of postoperative hypoxaemia which is likely to occur in such patients and which might otherwise cause a dangerously low oxygen content of the arterial blood.

In emergency surgery, where such pre-operative treatment is not possible, one must be prepared to monitor arterial blood gas tensions and to adjust inspired oxygen tensions accordingly.

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REFERENCES


BOOK REVIEW


This is the ninth volume in the *Clinical Anesthesia* series and the third and last of 1965. It reflects almost entirely the wide-ranging interest and industry of Dr. J. J. Bonica who has made the major contribution to six out of the eight chapters whilst editing the whole text. Indeed both he, in his preface, and Dr. Joseph Artusio jr., in his introduction, make the point that this book is part of a complete work on obstetric analgesia and anaesthesia that will shortly appear under Dr. Bonica’s name. Such a book coming from one with a deservedly high reputation will be an event of considerable interest to all anaesthetists who work in the field of obstetrics. Furthermore, it will very likely enable this volume to be reviewed in a better perspective than is possible at the present time, for it currently appears to emphasize obstetrics rather than anaesthesia. This is no great fault, since to have a knowledge of abnormal obstetrics is an asset appreciated by all who try to provide safe analgesia and anaesthesia during pregnancy and labour.

The chapters tell the story. Three are on anaesthetic management, namely of parturients with toxæmia, in the presence of placenta praevia, abruptio placenta or rupture of the uterus, and of dystocia due to abnormal passage. One is on the parturient in shock, and the remaining four relate to obstetrics, covering dysfunction of the forces of labour, abnormal presentation, breech delivery and grand multipara and other complications of pregnancy and labour. The subject matter is more evenly spread than the chapter headings suggest, and the advice so far as anaesthetic management is concerned is reasoned and practical. This is an excellent work of reference to the complications of obstetrics and their anaesthetic management, but it is well to note that the complications of anaesthesia related to obstetrics are not included.

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