Parenteral nutrition in surgery

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Introduction

While failure of other systems is well recognized, gastrointestinal failure, either complete or partial, occurs more often than is appreciated in surgical practice. Parenteral nutrition has to be employed in these circumstances either totally to replace alimentation or to supplement it. According to Lee (1975), only 1% of all patients will require intravenous nutrition, but this group raises many problems because of the associated severe illness and rigorous demands on medical and nursing care and laboratory control. The surgeon today is fortunate in that he can take advantage of a great body of experience with this procedure and also can readily employ many useful agents to supply all the necessary requirements (Peaston, 1967; Lee, 1974).

Background considerations

It is quite obvious that most patients are well able to tolerate the short period of reduced energy intake and increased energy expenditure associated with surgery and trauma. However, a complacent attitude to this period of starvation by the surgeon is one of the factors responsible for the delay in instituting parenteral nutrition. Most patients with severe illness are already energy-depleted whenever a decision is made to engage upon parenteral nutrition. Weight loss in excess of approximately 300 g/d is undesirable, and the patient undergoing a major operation may lose between 4 and 8% of total body-weight. This loss may require 6–8 weeks to restore. Survival becomes dubious if the weight loss is in excess of 30% (Lee, 1975). The catabolic effects of trauma and surgery are usually monitored by means of the urinary nitrogen excretion. This often rises to values between 7 and 15 g/d for the first 2–5 d, but if the trauma is more extensive it may be as high as 20 or even 40 g/d. A patient with a daily negative N balance of 15 g will lose almost 0·5 kg muscle tissue; hence the patient who is in a catabolic state and who is not being adequately fed will literally melt away.

Sources of energy

Normally the body stores approximately 100–200 g carbohydrate, chiefly in the form of glycogen, which may be exhausted within 24 h. Protein (4 kg) and fat (12–15 kg) are next consumed. Since the labile protein is insignificant the loss of fixed protein results in muscle wasting. At this stage the body is burning its

essential furniture, with the result that there is a lowered resistance to infection, wound healing is slow, the patient may become depressed and apathetic, oedema may occur and the convalescence may slow down.

Gastrointestinal failure

Gastrointestinal failure can occur in many clinical situations. However, the most obvious examples are patients who are unable to eat from carcinoma of the oesophagus or stomach, or who are unable to absorb, as in chronic intestinal obstruction, Crohn's disease or massive resection of the intestines. In the postoperative period, problems may arise with prolonged paralytic ileus, intestinal obstruction or fistula. In a report on the management of gastrointestinal fistula (Sheldon, Gardiner, Way & Dunphy, 1971) the importance of parenteral nutrition is stressed and was one of the factors that lowered the mortality following small intestine fistula. As well as the necessity for adequate nutrition, the other priorities are control of infection, aggressive diagnostic manoeuvres and judicious resort to surgical procedures. Special problems arise in other areas, as in major operations of the head and neck (Littlewood & Peaston, 1965). The use of intermittent positive pressure treatment of severe chest injury also calls for adequate nutritional replacement.

Regional considerations

Considerable attention has been given to the over-all metabolic behaviour in surgery and trauma. It is of interest to note that regional differences can occur. In a study on the ATP level of human muscle it has been shown that a procedure such as continuous retraction during surgery greatly depletes the ATP levels of muscle (Keaveny, FitzGerald & O'Boyle, 1973). Furthermore, in chronic ischaemia such as occurs in the gangrenous limb of a patient with advanced arteriosclerosis, wound healing has been shown to be slow in those patients with a profoundly depressed ATP level in muscle. Carrying these investigations further, the effect of haemorrhage was investigated on the adenine nucleotide levels of the pancreas, spleen, duodenum, and liver of the dog undergoing severe haemorrhagic shock (Keaveny, Cunningham & FitzGerald, 1975). The levels were found to be grossly depleted. However, when we prevented the irreversible breakdown of the nucleotides into uric acid by giving allopurinol prior to haemorrhage, the ATP levels were found to be significantly spared. These observations emphasize the importance of considering regional variations that occur in energy levels during surgery, trauma and hypotension and suggest that the energy supply should be undertaken in conjunction with methods to spare possible energy sources in the body as well as taking regional variations into consideration.

Design of parenteral nutrition

Under resting conditions the normal adult requires 100 kJ/kg body-weight per d in addition to 30 ml water, 1 g amino acids, 2 g carbohydrate and 2 g fat. When

metabolism is increased these requirements are approximately doubled. The aim of parenteral nutrition should be to supply 12–14 MJ in each 24 h, with extra allowance in the event of pyrexia. The major sources of energy are carbohydrate and fats.

Carbohydrate. The two most commonly used solutions are glucose and fructose. High concentrations of carbohydrate have to be used to supply adequate energy. These solutions may give rise to thrombophlebitis and are not suitable for prolonged use. Fructose is probably better (Weichselbaum, Elman & Lund, 1950) but may give rise to lacticacidosis.

Fats. Fats are a rich source of energy and it is fortunate that suitable preparations for intravenous use are now readily available. The preparation commonly used is a soya-bean preparation, Intralipid (Paines & Byrne Ltd, Greenford, Middx.). Although reactions such as pyrexia, headaches, backache, dyspnoea and urticaria are described, slight fever is the only reaction that is seen at all commonly. The intake of intravenous fat is usually limited to 3 g/kg body-weight per d.

Protein. Protein may be supplied as blood, plasma or albumin solutions. However, since protein infused as such has to be converted to amino acids it is much more efficient to supply the amino acids directly. The preparation in common use is a casein hydrolysate, Aminosol (Paines & Byrne Ltd). Synthetic amino acid preparations are now available which supply amino acids in the L-form, which is the form that the body uses to a significant extent.

Other requirements. Other requirements include water and electrolytes which must be supplied in accurate and adequate amounts. Acid-base status will require adjustment in these gravely ill patients. Vitamin supplements can be readily provided by intravenous injection of a multi-vitamin preparation twice weekly. On occasions deficiencies of trace elements may arise and these will have to be supplied.

Practical problems and case history

The following case history illustrates the value of parenteral nutrition. The patient, a 52-year-old farmer, was admitted with lower abdominal pain, distension of the abdomen, oliguria and pyrexia and leucocytosis. He was found to have generalized severe peritonitis as a result of a neglected, perforated duodenal ulcer. At laparotomy multiple abscesses within the peritoneal cavity were found, peritoneal toilet was carried out with antibiotics and the abdomen closed with drainage. As the patient had been ill for many weeks prior to his admission, it was obvious that his nutritional state was extremely poor. Postoperatively, the patient was initially given dextrose–saline solutions (Fig. 1). Aminosol fructose ethanol complex (Paines & Byrne Ltd) was then commenced to supply most of the energy requirements. A few days postoperatively, intravenous fat in the form of Intralipid was introduced and this brought the daily energy intake to over 10·5 MJ. After a short time laevulose was added, initially in a 200 g/l solution which was increased

to 400 g/l. With a combination of these preparations the intake was now over 15 MJ/d and continued at that for the remainder of the postoperative period.
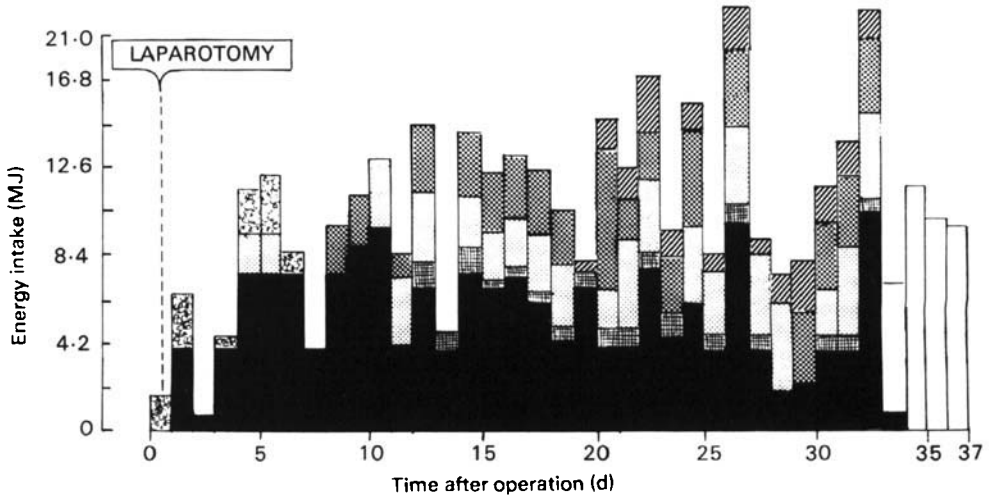

Fig. 1. Parenteral nutrition scheme for a 52-year-old man following laparotomy. All solutions were administered through a central venous catheter introduced through the long saphenous vein at the groin: ▨, dextrose–saline; ▨, laevulose; ▨, Intralipid (Paines & Byrne Ltd, Greenford, Middx.); ■, Aminosol (Paines & Byrne Ltd); ▨, Aminosol fructose ethanol complex (Paines & Byrne Ltd); ■, oral liquid feeds; □, solids.
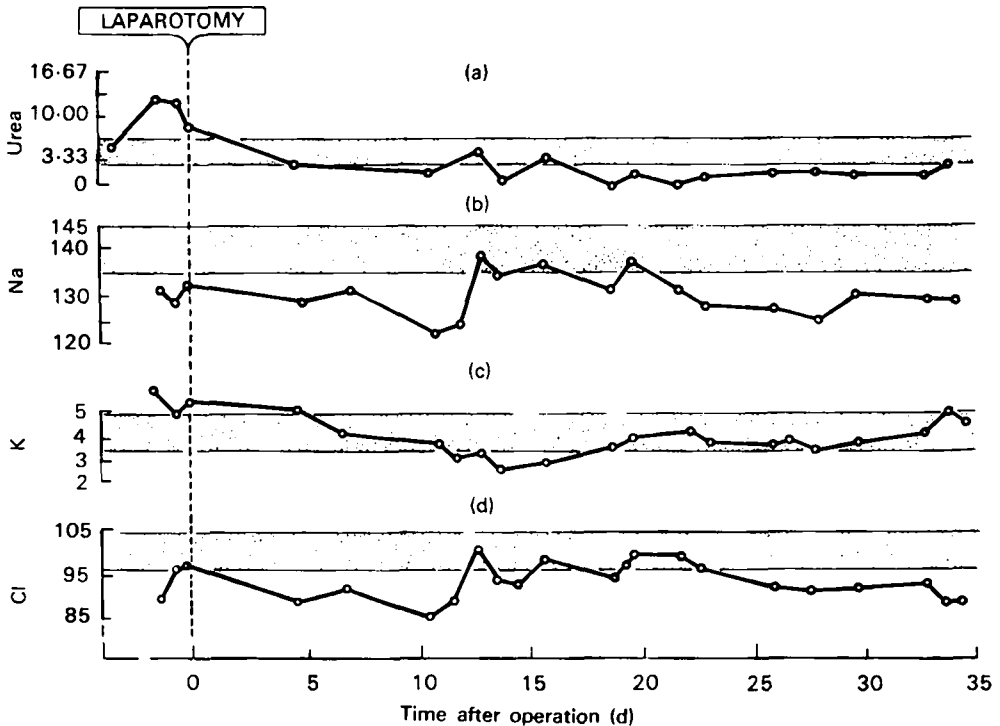

Fig. 2. Blood urea and electrolyte profile (mmol/l) of a 52-year-old man receiving parenteral nutrition following laparotomy: (a) urea, (b) sodium, (c) potassium, (d) chloride; ▨, normal range.

The combined solutions therefore consisted of the following (/d): Aminosol fructose ethanol complex 2 l, supplying 7·35 MJ; Aminosol (100 g/l) 0·5 l, supplying 0·65 MJ; Intralipid (200 g/l) 0·5 l, supplying 4·20 MJ; laevulose (400 g/l) 0·5 l, supplying 3·40 MJ (total 15·60 MJ). Heparin was added to each bottle and the solutions were administered through a central venous catheter introduced through the long saphenous vein at the groin. After 3 weeks of exclusive parenteral nutrition small oral supplements were commenced, accounting for 2 MJ/d. At the same time fluid and electrolyte balance were observed (Fig. 2). The urea level was high pre-operatively, but dropped to normal limits when the patient commenced his intravenous therapy. The potassium level fell below normal postoperatively. This decrease in K has been observed with the use of intravenous fat solutions. This necessitated the addition of 65–75 mmol potassium chloride/24 h to the solutions. Sodium and chloride also decreased postoperatively. This was counteracted by hypertonic saline. Anaemia was corrected by intramuscular and oral iron supplements. The fluid balance (Fig. 3) was carefully monitored. Initially, the bulk of the input was supplied intravenously, but as the patient improved oral supplements were added. The albumin level remained at the lower limit of normal. Apart from a marginally elevated serum alanine aminotransferase (*EC* 2.6.1.2) and alkaline phosphatase (*EC* 3.1.3.1), the patient's liver function tests otherwise were
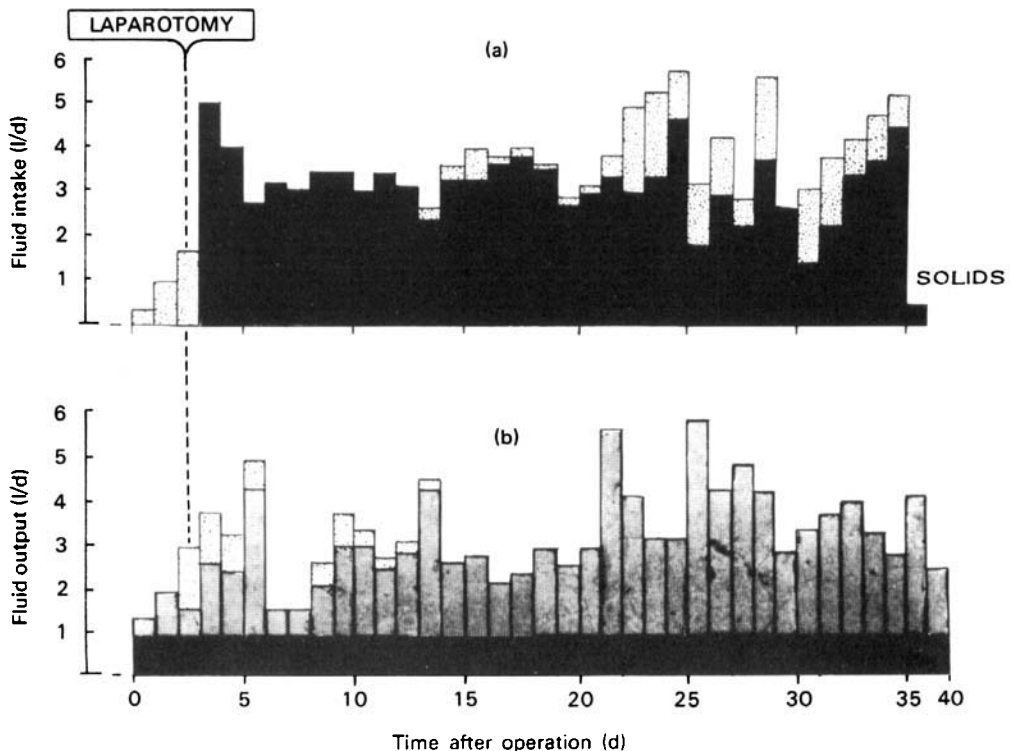

Fig. 3. Fluid balance of a 52-year-old man receiving parenteral nutrition following laparotomy. (a) Fluid intake: ▨, oral; ■, intravenous. (b) Fluid output: ▨, nasogastric tube; ▨, urine; ■, insensible loss.

normal. The pyrexia and leucocytosis responded to antibiotics. The abdominal circumference (Fig. 4) was measured daily. With return of bowel sounds the circumference decreased. Rectal examination 2 weeks after laparotomy revealed a pelvic abscess which spontaneously discharged into the rectum. The abdominal wounds and drainage incisions healed remarkably quickly. At all times the patient remained active, mentally and physically. He was capable of walking around the ward with the intravenous fluid bottle supported on a portable drip stand. Weight dropped only slightly throughout the period. After 5 weeks of parenteral nutrition all drips were discontinued and the patient commenced on oral foods. He was then discharged from hospital on iron therapy and anabolic steroids.
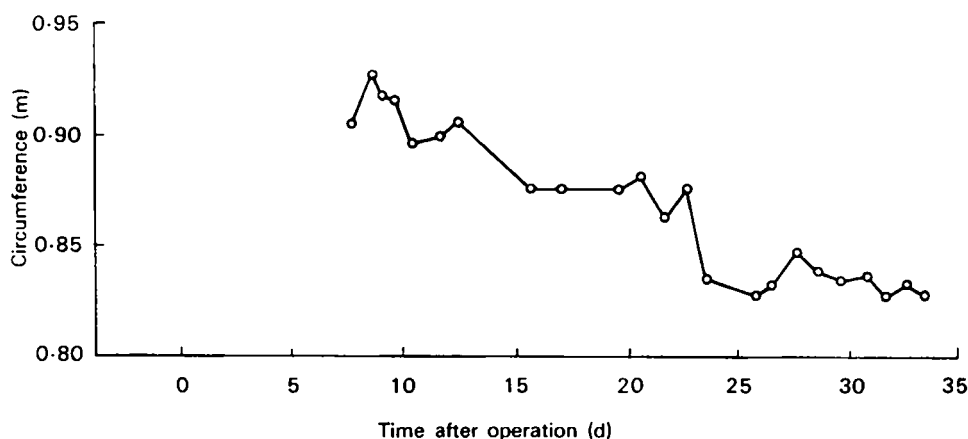

Fig. 4. Variation in abdominal circumference (m) of a 52-year-old man following laparotomy, showing reduction in abdominal distension with clinical improvement.

Comment

As with other reports on parenteral nutrition, one of the major problems is maintaining an adequate infusion route. At the outset it is preferable to cannulate a central vein. Avoidance of sepsis is essential since the patient is already at risk because of his energy depletion and severe illness. An antimicrobial cream at the site of entry is of value. The other possible complications are metabolic acidosis, febrile reactions from fat, hypophosphataemia and lacticacidosis. A further problem is that of cost, which can be considerable when the treatment is maintained over a period of weeks. Normal healing can take place and full substitution of the patient's requirements can be supplied until gastrointestinal failure reverses and normal alimentation resumes.

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