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CASE REPORT

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A death resulting from inadvertent intravenous infusion of enteral feed

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Abstract A female patient suffering from the after-effects of an intracerebral hemorrhage, inadvertently received approximately 50 ml of enteral feed containing high molecular weight dextrin intravenously and died 6 h later despite intensive emergency resuscitation attempts. The total quantity of enteral feed received was calculated from the amounts of dextrin measured in the blood. This is the first report describing how the total quantity of enteral feed administered intravenously was determined using biochemical analysis.

Keywords Dextrin · Enteral feed · Gas chromatography · Gel filtration · Medical malpractice

Introduction

Enteral alimentation obviates many of the risks associated with total parenteral nutrition, and may be delivered via nasogastric, gastrostomy, or jejunostomy routes. A rare, but devastating risk of enteral feeding is the inadvertent administration via the intravenous route. Previous reports have described cases of both fatal (Donovan 1979; Casewell and Philpott-Howard 1983) and non-fatal (Ulicny and Korelitz 1989; Stellato et al. 1984; Malone et al. 1993; Ong and Soo 1997; Kennelly and Barnes 1998; Stapleton et al. 1988) outcome when polymeric enteral feeds were administered in error via intravenous catheters.

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This third report of inadvertent fatal administration of enteral feed via a venous catheter is presented.

Case history and autopsy findings

A 77-year-old woman with an intracerebral hemorrhage due to hypertension was receiving commercially prepared enteral feed (Low Residual Liquid Formula MA-8, Morinaga-Nyugyo, Japan). The feed was delivered to the patient through a plastic tube that was continuous with its container bag and terminated in a connector that fitted into the nasogastric tube. Following the sudden collapse of the patient, it was found that the connector from the feed bag had been inadvertently inserted into one of the two ports in the three-way tap of the central venous pressure line. An unknown quantity of enteral feed had already entered the superior vena cava. Within the next hour the patient developed tachycardia and dyspnoea, and death occurred 6 h later despite intensive resuscitation attempts.

An autopsy was carried out 1 day after death. The deceased was 145 cm tall, weighed 47 kg and was of average build. There was a small incised wound in the right infraclavicular area for central venous hyperalimentation. On brain sectioning an old cystic lesion in the right internal capsule and gliotic changes with yellow discolouration in the right cerebellar hemisphere were present. The heart was slightly hypertrophied, flaccid and weighed 400 g. No myocardial ischemic changes were observed. The mucosa of the trachea and bronchi were covered with foamy material, the lungs showed diffuse edema, contained a foamy fluid and weighed 220 g (left) and 340 g (right). The carotids, vertebrobasilar system and circle of Willis showed marked atherosclerotic changes. Microscopic examination confirmed all the main changes observed macroscopically. The cerebral tissue and lungs showed marked congestion and edema of the pulmonary parenchyma was observed. The kidneys showed tubular swelling and degeneration and glomerular swelling. There were no lipid globules or emboli in the renal glomeruli or the lung and brain capillaries. All other tissues showed no major abnormalities. The cause of death was pathologically diagnosed as acute respiratory failure due to inadvertent intravenous infusion of enteral feed.

Materials and methods

All procedures were carried out at 0–4 °C. According to the manufacturer, each 100 ml of the enteral feed (MA-8) contained 4 g protein, 3 g lipid, 14.3 g carbohydrate (main component was dextrin), 0.4 g cellulose, 0.5 g ash, 75 mg sodium, 95 mg potassium, 110 mg chloride, 60 mg calcium, 60 mg phosphorus, 20 mg magnesium,

multivitamins and trace elements. The pH was 6.8, osmotic pressure 280 mosm/kg H_2O, viscosity 11 cP (20 °C) and specific gravity 1.07. Isolation of dextrin from the feed, blood and lungs was performed using gel filtration on Sephacryl-200 HR columns (Pharmacia Biotech, Japan). Samples (7 ml) of the feed and the patient's blood were dialysed against 50 mM Tris-HCl buffer, pH 7.5, containing 0.15 M NaCl (solution A). A portion of lung tissue (8 g) was cut into small pieces, submerged in 8 ml of cold solution A and kept at 4 °C overnight with gentle shaking. After centrifugation of the solution at 10,000 *g* for 10 min, the supernatant was dialysed into solution A. Each dialysate was centrifuged at 10,000 *g* for 10 min, and the supernatant was applied to a Sephacryl-200 HR column (1.6 × 95 cm) pre-equilibrated with solution A. Quantitative analysis of dextrin was performed by the phenol-sulfuric acid method (Dubois et al. 1956) with a known standard. As a control, we used two sets of blood and lung samples collected from two other deceased persons who were killed in a traffic accident.

The dextrin was hydrolysed with 5 N HCl and then trimethylsilylated according to a previously described method (Takeshita et al. 1995). The trimethylsilylated derivatives were analysed using a Shimadzu GC-18A gas chromatograph (Kyoto, Japan) with a flame ionization detector equipped with a capillary column (DB-1701, 30 m × 0.249 mm id × 0.25 μm df).

Results

Dextrin was chosen as the marker for the presence of MA-8, as it is one of the main components of MA-8 and has a very large molecular mass: it is a water-soluble degradation product of starch and consists of glucose units linked by 1,4-α-glycosidic bonds with about 25% of 1,6 linkages remaining from the original starch. In order to isolate the dextrin from MA-8, blood and lung samples, gel filtration was used on Sephacryl-200 HR and sugar-positive peaks were monitored (Fig. 1). Only one sugar-positive peak was detected from the MA-8 sample in a void volume of the column (Fig. 1a). Samples of blood and lung tissue from the deceased gave two sugar-positive peaks: the first (early eluted) peak occupied the same position as the MA-8 peak (Fig. 1b) and the second (later eluted) peak appeared about 50 ml from the first peak. The two control sets of blood and lung samples showed only one peak, which was identical with the second peak of the deceased patient's samples (Fig. 1c). It was assumed that the first peak from the blood and lungs of the deceased patient was derived from the dextrin.

A part of the fraction collected from the peak of the MA-8 sample, and the first peak of the deceased patient's blood and lung samples, was hydrolysed and analysed by gas chromatography to identify glucose alone. From this, it was concluded that the first peak of the deceased's samples contained dextrin derived from the enteral feed MA-8. The molecular mass of the dextrin was determined to be more than 100 kDa by gel filtration, and was not excreted into the primary urine. From the colourimetric quantitative analyses of the first peak fractions, the concentrations of dextrin in the blood, lungs and MA-8 were estimated to be 2.1 mg/ml, 2.4 mg/g and 137 mg/ml, respectively. The total circulating blood volume of the deceased was estimated to be approximately 3100 ml (65.7 ml/kg × 47 kg). Although we could not estimate exactly how much of the originally administered dextrin had been eliminated up to the time of death, the metabolism of dextrin is known to be extremely slow (Bibby et al. 1977), and metabolically degraded forms of dextrin with smaller molecular masses could not be identified in the blood and lung samples by gel filtration. From these findings, the dose of dextrin administered to the deceased was estimated to have been at least about 6.5 g, approximately equal to 50 ml of MA-8.

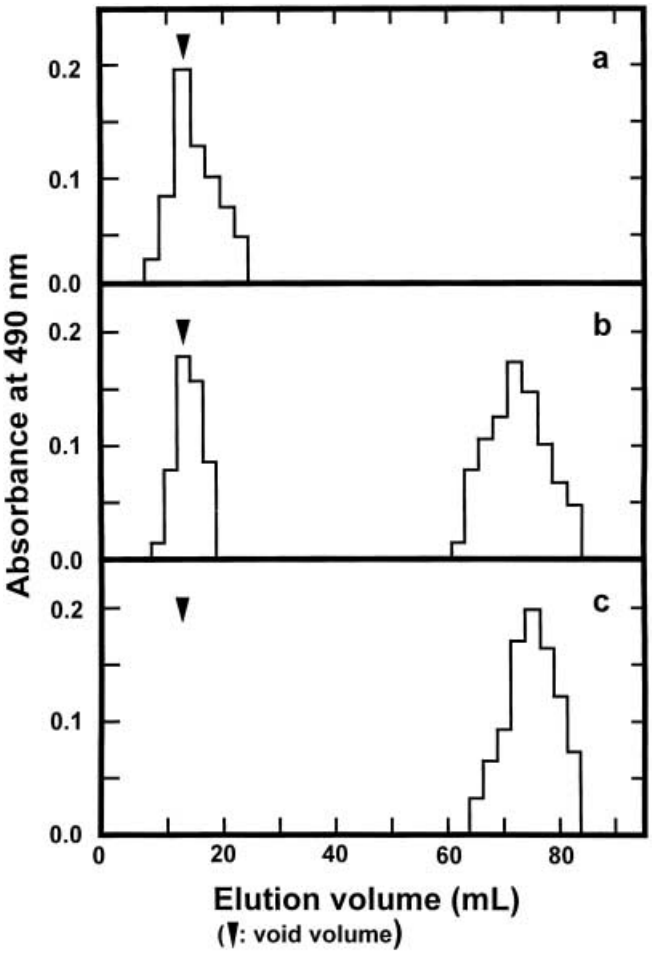

Fig. 1 Gel filtration profiles on a Sephacryl-200 HR column (1.6 × 95 cm) for **a** enteral feed MA-8, **b** the deceased's blood and **c** control blood (the column was eluted with 50 mM Tris-HCl buffer, pH 7.5, containing 0.15 M NaCl at a flow rate of 10 ml/h and the eluate was collected in 3.0 ml fractions. Quantitative analysis of dextrin was performed by the phenol-sulfuric acid method. The gel filtration profiles of lung extract were very similar, data not shown)

Discussion

In two previously reported fatal cases (Donovan 1979; Casewell and Philpott-Howard 1983), the patients received unknown amounts of enteral feed; however, in seven non-fatal cases, the patients received 15 ml (Kennelly and Barnes 1998) up to 400 ml (Ulicny and Korelitz 1989). Morbidity associated with the parenteral infusion of en-

teral feed may be attributed to several factors: osmolality, intravascular coagulation, microembolisation of soluble/insoluble particles and fat globules, bacteraemia, and hypersensitivity to the various components of the feeds (Stellato et al. 1984; Ong and Soo 1997). In this case, there was no histopathology confirmation of either a microembolism phenomenon or of intravascular coagulation in the susceptible organ systems. As components of enteral feeds, in terms of content and concentration will vary from product to product, there is no consensus on the risks of intravenous administration of enteral feeds. This is the first report that describes how the total quantity of enteral feed administered intravenously was determined by using biochemical analysis of blood from the deceased.

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