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Original article

Reduced need for replacement of long term parenteral nutrition catheters following endoluminal brushing

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SUMMARY

Background & aims: Patients with Intestinal failure (IF) on long-term nutritional support (IF Type 3) through parenteral nutrition (PN) require invasive venous access to provide nutritional compounds. Central venous catheters (CVC) are at risk of complications including microbial infections and occlusion. Occlusions can be resolved by administering parenteral solutions to achieve patency. However, we report an alternative methodology for salvaging occluded CVCs and achieving patency using endoluminal brushing.

Methods: Patients admitted with a CVC occlusion to one of the two national IF centres in the UK, were entered into a prospectively managed database and the data were then analysed retrospectively. The study used data from patients who had CVC occlusions from December 2003 to March 2006 (Cohort 1) and from April 2006 to September 2010 (Cohort 2). Cohort 1 included occluded CVCs managed using endoluminal brushing and the split of cohorts was determined by the availability of endoluminal brushes. Cohort 2 included occluded CVCs managed using a 'standard' technique of urokinase with or without adjuncts such as Ethanol, Hydrochloric acid or Sodium hydroxide. If therapy failed, the CVC was removed. Data were recorded on success of achieving patency and occurrence of re-occlusion.

Results: 66 episodes of CVC occlusion from 44 patients occurred in Cohort 1, compared to 68 episodes in 45 patients in Cohort 2. There was no difference in gender, age, median time on TPN prior to occlusive episode or disease aetiology. The number of CVCs where patency was achieved was 57 (86%) in Cohort 1 compared to 34 (50%) in Cohort 2 ($p < 0.0001$). Consequently, the number of CVCs replaced were 9 (14%) in Cohort 1 compared to 34 (50%) in Cohort 2 ($p < 0.0001$). There were no complications associated with endoluminal brushing or 'standard' therapy.

Conclusion: This is the first report of the safe and effective use of endoluminal brushing to manage occluded CVCs in patients requiring long-term parenteral nutrition.

1. Introduction

Intestinal failure (IF) can result from different aetiological insults on the GI tract, such that the resulting absorptive capacity is unable to meet the nutritional requirements of the individual concerned, whether energy, fluid, micronutrients or electrolytes. It can be divided into three broad categories: Type 1 is self-limiting failure observed after abdominal surgery; Type 2 occurs following extensive resection that results in nutritional, metabolic and septic sequelae necessitating a multidisciplinary team approach to aid recovery; or Type 3, where chronic IF requires long-term nutritional support.[1] Parenteral nutrition (PN) is vital to support patients with Type 3 IF and requires invasive long-term venous access to provide nutritional compounds. Unfortunately, central venous catheters (CVCs) are at risk of complications; these include CVC microbial infections, which, in some cases, can be life threatening and can affect up to 0.14–0.83 episodes/patient year.[2–6] CVC occlusion is defined as partial or complete obstruction that results in limitation of flushing, withdrawing blood, administering medication or parenteral solutions and can result from fibrin, mineral and/or lipid deposits; this has been reported to have an incidence of 0.07 episodes/patient year.[7,8] Furthermore, both infections and occlusions can result in the need for replacement of the affected

Non-standard abbreviations: PN, parenteral nutrition; HPN, home parenteral nutrition; CVC, central venous catheter; IF, intestinal failure; IFU, intestinal failure unit; FAS, Fibrin Analysis System; CRS, catheter related sepsis.

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CVC and, whilst every opportunity is made to reuse the patient's venous access point, recurrent CVC replacements can result in increased risk of venous thrombosis and subsequent loss of venous access that may lead to the need for intestinal transplantation.[9–13]

A number of different approaches to the prevention and/or treatment of occluded CVCs have been evaluated; these include the use, alone or in combination, of heparin,[14,15] ethanol,[16,17] hydrochloric acid (HCl),[18–20] sodium hydroxide (NaOH)[21–23] and urokinase.[24,25] In addition, Fibrin Analysis System (FAS) endoluminal brushes have been used to successfully treat occluded CVCs in patients requiring haemodialysis,[26–28] although the experience is not universally positive.[29] For example, a small prospective uncontrolled study of 17 patients in two arms, with occluded and low flow haemodialysis catheters, showed that brushing was successful in opening 72% of blocked catheters and 60% of catheters with low flow; patency was maintained at 6 weeks in 50% of all cases.[28] However, the role of endoluminal brushes in relieving occluded CVCs in patients requiring long-term or home PN (HPN) has not previously been described.

The aim of this study was to evaluate the efficacy of using an endoluminal brush to manage occluded CVCs used for long-term HPN, with a primary outcome of reduced in CVC replacement. We report a retrospective study of data from a prospectively maintained cohort database, and demonstrate for the first time that endoluminal brushing is a safe alternative method of resolving occluded CVCs in patients requiring HPN.

2. Methods

All patients presenting to a national IF Unit (IFU) were entered prospectively onto a database. This was a retrospective study of these prospective data; details collected included timing of CVC insertion and rates of CVC occlusions. The study used data from patients who had CVC occlusions from December 2003 to March 2006 (1st cohort) and from April 2006 to September 2010 (2nd cohort). The split of cohorts was determined by the availability of endoluminal brushes, since the brushes became unavailable in the UK after 2006. The 2nd cohort is used as the comparator group where a 'standard' technique of unblocking CVCs was employed.

2.1. Management of occlusions

Patients with occluded CVCs – i.e. those experiencing partial or complete obstruction to flushing or administering PN – were either managed using the endoluminal 'brushing' protocol (1st cohort) or using the 'standard' protocol (2nd cohort).

2.2. Endoluminal brushing protocol

The brushes used were Fibrin Analysis System (FAS) brushes from FAS Medical Limited, UK. The brush was used according to manufacturer's standard protocol. In essence, aseptic technique was used to connect the brush to the CVC. The brush was then inserted into the lumen whilst covered by a sterile sheath. The brush was gently advanced until maximum position or obstruction was reached. The length of the CVC determined the maximum position of the brush. Following this, the brush was removed from the catheter lumen under aseptic techniques. After the brush was removed, an attempt was made to aspirate the CVC to remove loose debris; thereafter an attempt was made to flush the CVC with 10 mL 0.9% saline. The procedure was repeated up to five times. If brushing failed to achieve CVC patency, then the occluded CVC was removed and replaced.

2.3. Standard protocol

After 2006, CVC occlusions were managed according to standard protocols, where urokinase 5000 international units (iu)/mL was applied to the CVC and left *in situ* as a lock for 4–12 h, with up to 3 attempts if patency was not achieved. The other treatments used depended on whether the CVC was used for intravenous lipid emulsions, in which case the protocol commenced with 70% Ethanol for 1 h, followed by urokinase and finished with an HCl lock. For patients receiving glucose or electrolyte only PN, an HCl lock was used initially followed by urokinase. If the standard protocol failed to achieve patency, then the CVC was removed and replaced.

2.4. Statistical analysis

The statistical analysis was performed on Excel (Microsoft) spread-sheets and Prism (Graphpad). Statistical analysis included Student's *t* test, unpaired *t*-test, Chi squared and Mann–Whitney *U* test.

3. Results

Demographic and clinical details of patients are outlined in Table 1; no difference was noted between those patients included the 'Brushing' (Cohort 1) and 'Standard' protocols (Cohort 2, Table 1).

Successful CVC patency was achieved in significantly more episodes in Cohort 1 than in Cohort 2 (Table 2). Consequently, the number of CVC replacements required was significantly lower in Cohort 1 than in Cohort 2. At the start of the study period, a small proportion of occluded catheters (19/66 episodes) were initially pre-treated with standard therapy, but as positive experience developed with endoluminal brushing, the protocol was changed to the latter as the first line therapy.

Figure 1 shows the outcome of blocked CVCs analysed according to first or repeated episodes of CVC occlusion. If a CVC subsequently blocked following initial patency restoration, repeated endoluminal brushing was more successful in re-achieving patency than the standard protocol (100% following endoluminal brushing vs. 50% in standard protocol $p = 0.0046$ (Chi squared) Fig. 1).

Importantly, there were no complications in either group with the methods employed for unblocking occluded CVCs.

4. Discussion

This is the first report describing the safe use of endoluminal brushing for the management of occluded CVCs used for HPN. Our data demonstrate that mechanical endoluminal brushing is more

Table 1
Patient demographic and clinical details. Analysis: Student's *t*-test and Mann–Whitney *U* test.

Characteristics		Endoluminal brushing cohort 1	Standard protocol cohort 2	*p* Value
Number of patients		44	45	
Proportion male (%)		48	36	0.2492
Mean age (years)		46	53	0.0617
95% CI		±5.4	±4.1	
Median time on HPN (days)		55.5	35.0	0.7781
Range		3–267	1–339	
Disease aetiology (%)	Ischaemic	32	27	0.5981
	Crohn's	20	17	0.7658
	Dysmotility	23	29	0.5123
	Other	25	27	0.8595