Carbon dioxide use as contrast for vena cava filter implantation: case series

Implante de filtro de veia cava com uso de dióxido de carbono como meio de contraste: série de casos

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Abstract

Objective: To assess the use of digital subtraction with carbon dioxide (CO_2) for vena cava filter implant.
Methods: From April 2010 to February 2011, seven patients underwent inferior vena cava filter placement with digital subtraction angiography with the use of CO_2 as contrast media. All patients had iliac and femoral deep venous thrombosis and contraindications for anticoagulation.
Results: Technical success was achieved in all cases. Inferior vena cava e renal veins were identified in all cases. There were no evidences of complications related to the use of CO_2 during or after the procedure.
Conclusion: The placement of inferior vena cava filter with CO_2 and digital subtraction angiography is safe and effective with good results in patients with renal insufficiency and allergy to iodine.

Keywords: angiography; carbon dioxide; venous thrombosis.

Resumo

Objetivo: Avaliar o resultado do implante de filtro em veia cava inferior empregando angiografia digital por subtração com dioxide de carbono (CO_2) como meio de contraste.
Métodos: No periodo de abril de 2010 a fevereiro de 2011, sete pacientes foram submetidos ao implante de filtro na veia cava inferior, utilizando-se CO_2 como meio de contraste em subtração digital. Os pacientes apresentaram como critério de inclusão trombose venosa profunda no setor iliacofemoral e contraindicação a anticoagulação.
Resultados: Foi obtido sucesso tecnico em todos os casos, com adequada visualização da veia cava e veias renais, não havendo complicações relacionadas ao uso do CO_2 ou ao procedimento.
Conclusão: O implante de filtro de veia cava utilizando o CO_2 como meio de contraste é segura e efetiva em pacientes portadores de alergia ao contraste iodado ou com insuficiência renal não dialítica.

Palavras-chave: angiografia; dióxido de carbono; trombose venosa.

Introduction

Pulmonary embolism is an apparent paradox of modern Medicine – the greater the progress of medical technology, the higher the number of clinical situations that lead to thromboembolism. However, several technological developments have favored its diagnosis and treatment. Vena cava filter implantation is a common therapeutic option cava that is usually performed using iodine compounds as contrast media. Yet, some patients may develop contrast-induced nephropathy, which is the main cause of renal failure in hospitalized patients[1,2].

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Carbon dioxide (CO_2) was first used as contrast medium in the 1950's to diagnose pericardial effusion. With the advent of digital subtraction angiography (DSA) in 1980, angiography with CO_2 has become a useful tool for the diagnosis, especially in patients with allergy to iodinated contrast or with chronic renal failure under medical treatment.

Angiography with CO_2 can be used for the precise measurement of the inferior vena cava diameter, evaluation of anatomical features and evidence of non-occlusive thrombi, venous stenosis and even occlusions. It can also guide percutaneous interventions, such as vena cava filter implantation or vena cava recanalization[3-5].

The objective of this study was to report a series of seven patients submitted to inferior vena cava filter placement using CO_2 as contrast medium.

Material and methods

A single-center study was conducted from April 2010 to February 2011 in patients with deep venous thrombosis involving the iliac and femoral veins and contraindications to anticoagulation and to the use of iodinated contrast.

The procedures were performed in the operating room. The patients were submitted to local anesthesia and common femoral vein puncture through the Seldinger technique. The injection system employed a 60 mL syringe with *Luer Lock* attached to a 3-way tap, which had one of its ways connected to a latex tube attached to the insufflator normally used in laparoscopic surgery (Electronicendoflator264305 20, Karl Storz Endoskope, Tuttlingen, Germany). Before using the CO_2 injection system, all gas should be aspirated and the contents of the syringe should be purged in the environment three times, to avoid air contamination. After that, the remaining way is connected to the side way of the sheath that is part of the filter delivery system (Figure 1). In all cases, the Vena Tech LP® (BBraun, Melsungen, Germany) filter was implanted.

The procedure started with pre-procedure cavography with the injection of 60 mL of CO_2 for vena cava analysis, to determine the inferior vena cava morphology and to find the ostia of the renal veins (Figure 2). After that, the filter was implanted following the manufacturer's instructions. A control cavography was performed after filter placement, with the injection of 60 mL of CO_2 (Figure 3). A three-minute period between CO_2 injections was observed[3].

Results

From April 2010 to February 2011, 45 patients were submitted to inferior vena cava filter placement. Seven patients presented contraindications to the use of iodinated contrast and were submitted to the procedure using CO_2 as contrast medium. We observed that four patients had non-dialysis renal failure and three patients had allergy to iodine. On average, 120 mL of CO_2 were injected in each procedure.

Table 1 shows the characteristics of the studied population. All patients presented iliac and femoral deep venous thrombosis and contraindications to anticoagulation.

Technical success was achieved in all cases and no complications were observed in post-operative follow-up regarding the procedure or the use of CO_2.

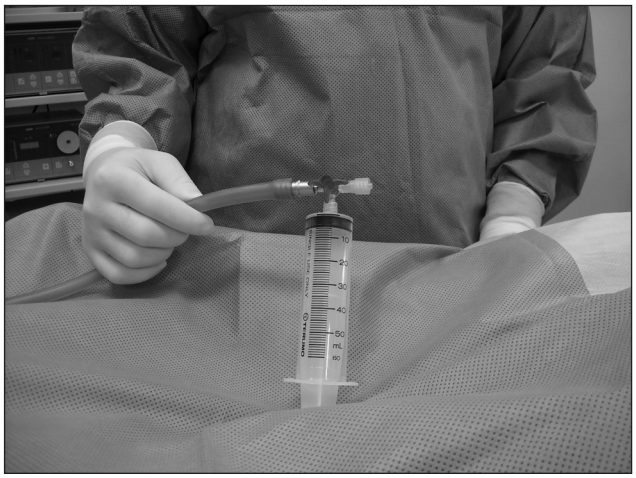

Figure 1. System used to inject carbon dioxide (hose, 3-way tap and 60 mL syringe).

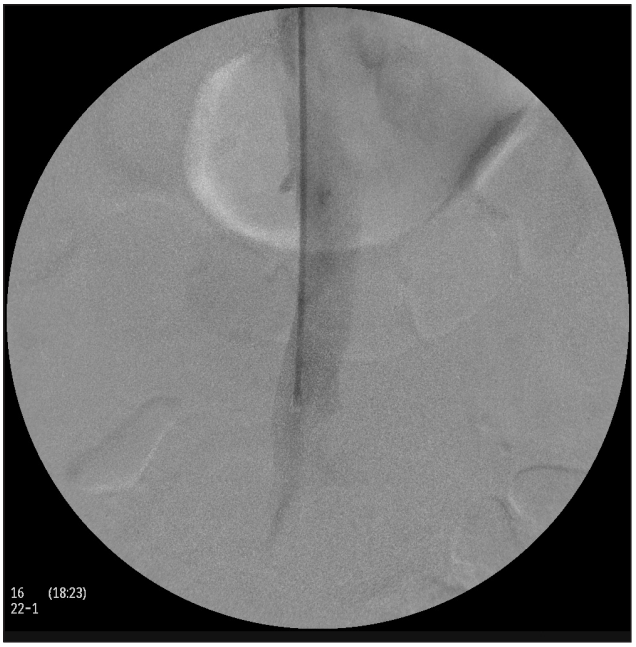

Figure 2. Inferior vena cavography with carbon dioxide.

Figure 3. Inferior vena cavography with carbon dioxide, showing the vena cava filter in a proper position.

Table 1. Group of patients submitted to vena cava filter implantation with carbon dioxide (CO_2).

Patient	Age	Sex	Contraindication to anticoagulation	Contraindication to CO_2
DF	86	F	digestive hemorrhage	NDCRF
ET	71	F	digestive hemorrhage	allergy
RS	83	F	digestive hemorrhage	NDCRF
MB	77	F	digestive hemorrhage	NDCRF
HS	68	M	gross hematuria	allergy
SC	52	F	polytrauma	allergy
DP	78	F	digestive hemorrhage	NDCRF

M – male; F – female; NDCRF – non-dialysis chronic renal failure.

Discussion

Evidence has been reported suggesting that the nephrotoxic effects of iodinated contrast on renal parenchyma are not temporary, but permanent and cumulative[3,6,7]. Patients with chronic renal failure under medical treatment, or with allergy to iodinated contrast benefit from vena cava filter placement using alternative or no contrast media[4-7].

Besides CO_2, it is possible to implant vena cava filters using gadolinium or the ultrasound-guided technique, which do not use contrast[8]. Some authors report the use of gadolinium as an alternative to iodinated compounds. However, when compared to CO_2, it also presents lower radiographic density than iodinated contrast and it is associated with the development of nephrogenic systemic fibrosis in patients with renal failure[9,10].

CO_2 is a low-cost, readily available medium in most operating rooms. It requires only a canister of pure CO_2, a laparoscopic insufflator and a sterile hose to connect the insufflator to the injection syringe.

Precautions should be adopted to avoid contamination with ambient air. CO_2 is a colorless and odorless gas and it cannot be visibly distinguished from air. The incorrect application of this gas may result in air contamination, which may cause air embolism[11]. It is recommended to purge the injection syringe three times, i.e., it should be filled with CO_2 and emptied three times in order to keep only CO_2 in the system.

The injected volume of CO_2 and the time interval between the injections should be observed, especially if the patient develops pain or hypotension. In our practice, we administered the injections with a minimum of three minutes intervals. CO_2 is about 20 times more soluble than oxygen. When injected into a blood vessel, bubbles of CO_2 are fully dissolved within two to three minutes. For patients with chronic obstructive pulmonary disease, the amount per injection should be reduced and the time interval between injections should be increased[4,5,11].

CO_2 is exhaled in a single passage through the lungs. However, the bubbles injected in the venous system may cross into the arterial system through the patent foramen ovale or other septal defects into the heart[3,4]. There are no absolute contraindications to CO_2. However, it is prudent to avoid using it in the thoracic aorta due to the risk of gas embolism in the spinal, coronary and carotid arteries[4,5].

Because of its lower radiographic density, the CO_2 contrast images present lower quality than iodinated contrast. The use of digital subtraction angiography helps improving image quality. In some cases, several injections of CO_2 may be required, which increases the operator and the patient's exposure to radiation.

Conclusion

The use of CO_2 as a contrast medium for vena cava filter placement is an option that presents satisfactory results in patients with allergy to iodinated contrast or non-dialysis renal failure.

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