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Femoral versus jugular access for Denali Vena Cava Filter placement: Analysis of fluoroscopic time, filter tilt and retrieval outcomes

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ABSTRACT

Purpose: To analyze relevant metrics involved in Denali Vena Cava Filter placement via different venous access sites.

Materials and methods: Patients with Denali filters inserted between March 2017 and February 2018 were retrospectively analyzed. Pre-procedural and pre-retrieval computed tomography (CT) were reviewed. We compared inferior vena cava (IVC) diameter, filter tilt angle, filter tip IVC wall abutment, fluoroscopy time, and retrieval outcomes by venous access site. Filter tip abutment/limb penetration and procedure-related complications were investigated.

Results: Seventy-eight patients had successfully-placed Denali filters. Seventy-one of 78 (91%) patients had both pre-procedural and pre-retrieval CT. The majority (35 [49%]) were placed via the right femoral vein (left femoral vein: 22 [31%]; right internal jugular vein: 14 [20%]). The jugular approach involved a longer fluoroscopy time (mean 117 ± 37 s [s]) than the right and left femoral approaches (mean 64 ± 21 s, mean 67 ± 15 s, respectively [$p < 0.05$]). Filter tilt and filter tip abutment were not significantly different between the 3 access routes. Filter tip abutment and limb penetration were observed in 8/71 (11%) and 2/71 (3%) patients, respectively. Filter retrieval was attempted in 68 of 78 (87%) cases, and all filters were successfully retrieved. One filter arm fractured during advanced retrieval; no other procedure related complications were recorded.

Conclusions: Both femoral venous approaches can be safely used for placement of the Denali filter. Femoral venous access involved a shorter fluoroscopy time without any differences in filter tilt and filter tip abutment compared to transjugular access.

1. Introduction

Deep vein thrombosis (DVT) can cause life threatening pulmonary thromboembolism (PTE) [1]. While anticoagulation agents are the primary option for treatment, some patients have contraindications to their use. The inferior vena cava (IVC) filter is an effective modality to reduce the risk of fatal PTE in patients who cannot be anticoagulated [2–5]. However, IVC filters have a number of complications, including retrieval failure of temporary filters and a risk of IVC thrombosis, embedded filter tip, strut penetration, filter fracture, or migration of permanent filters [6–9]. The recently-introduced Denali Vena Cava Filter (Bard, Peripheral Vascular, Temte, AZ) is a retrievable filter with a unique design that prevents filter tip abutment to the IVC wall. Studies have demonstrated that the Denali filter has a lower incidence of filter tilt and a high retrieval success rate [10–12]. There are various access sites used for IVC filter placement, including the jugular, subclavian, and femoral veins. Each of these approaches has certain disadvantages for placement of the IVC filter. The jugular and subclavian venous access approaches have the potential risk of inducing cardiac arrhythmias or cardiac perforation due to guidewire or catheter manipulation during placement of the IVC filter. In addition, placement of the filter in the IVC can take more time using these approaches. The femoral venous access approach introduces the potential risk of filter tilting due to the wider angulation between the filter delivery sheath and the IVC as compared to the jugular venous access approach [13]. To the best of our knowledge, this is the first study to investigate Denali filter placement according to different access sites. The objective of this study was to evaluate variations in filter tilting, procedure time, complications,

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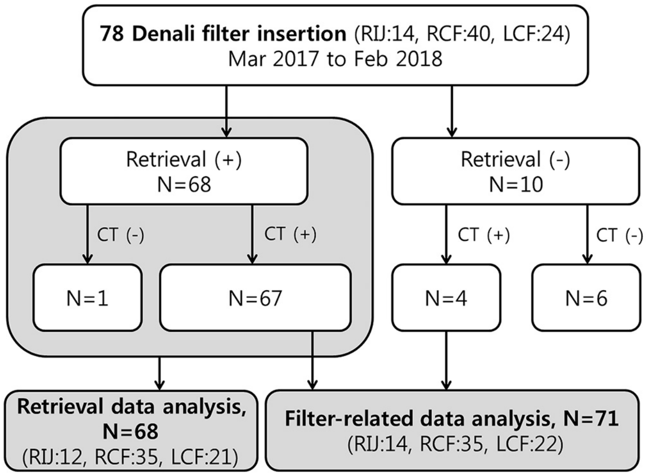

Fig. 1. A flow chart of study enrollment.
RIJ-right internal jugular
RCF-right common femoral
LCF-left common femoral.

and retrieval rate for Denali filter placement. We hypothesized that the femoral venous access approach may offer advantages in placement efficiency as compared to the jugular venous access approach due to the Denali filter's propensity for less filter tilting.

2. Materials and methods

2.1. Patient data collection and baseline IVC parameters

This study was approved by our center's Institutional Review Board, which waived the requirement for informed consent since this was a retrospective analysis. We analyzed data from all 78 patients who had Denali filters inserted between March 2017 and February 2018 at our institution. To evaluate filter tilt and filter tip abutment to the IVC wall, patients without a confirmatory pre-filter retrieval computed tomography (CT) scan were excluded (n = 7). Details of patients' enrolment of this study are shown in Fig. 1. Data from the electronic medical record system and the picture archiving and communication system (PACS) were reviewed to collect information about patient demographics, fluoroscopic time, and imaging measurements.

Baseline IVC parameters were measured on pre-procedural CT by 2 radiologists (OOO and OOO). Long, short, and circumferential IVC diameters were measured on axial CT images at the level of 4 cm below the lowest renal vein insertion. Averages of data measured by 2 radiologists were used for the analysis.

2.2. IVC filter insertion and retrieval

All Denali filter insertions were performed by one interventional radiologist (OOO). After local anesthesia with 2% lidocaine (Jeil Lidocaine, Seoul, Korea), venous access was obtained either through the right common femoral vein (RCF), the left common femoral vein (LCF) or the right internal jugular vein (RIJ). The selection of the access site was determined by the operator. The RCF was preferentially used; the LCF was used when venous access was limited due to the presence of an adjacent bone fracture that would limit compression for achievement of hemostasis or in the presence of an ipsilateral DVT. When contraindications to obtaining access existed in both femoral veins, the RIJ was used. All IVC filters were inserted into the infrarenal IVC. Ultrasound-guided venous access was performed using micro-puncture access sets (Cook Medical, Bloomington, IN). After serial dilation, digital subtraction inferior vena cavography was performed using a contrast injector pump with an injection rate of 15 ml/s (ml/s). A total volume of 30 ml was administered to identify the preferred location for insertion in the IVC relative to the renal vein and to check for the existence of any potential anatomic variants of the IVC prior to IVC filter deployment. Post-procedural subtraction vena cavography was obtained immediately after IVC filter deployment using manual injection of 15-20 ml of contrast media. Indications for IVC filter insertion are summarized in Table 1 and are categorized according to the Society of Interventional Radiology guidelines [14]. IVC filter retrieval was attempted via the right jugular vein with the usual endovascular snare technique. If the snare technique failed, additional retrieval attempts were made using alternative devices. Procedure related complications were also analyzed.

Table 1
Indications of IVC filter insertion

Indications of IVC filter insertion	Overall (n = 78)	Study enroll (n = 71)
Evidence of PE or iliac, femoropopliteal DVT with contraindication to anticoagulation	n = 39	n = 34
Evidence of below the knee DVT with multiple long-bone fracture and contraindication to anticoagulation	n = 35	n = 34
Severe trauma without documented PE or DVT	n = 2	n = 1
Patients at high risk (immobilized)	n = 2	n = 2

IVC-inferior vena cava.
PE-pulmonary thromboembolism.
DVT-deep vein thrombosis.

2.3. Filter tilt and filter position

Filter tilt and filter tip abutment to the IVC were analyzed by two radiologists using a pre-filter retrieval venous phase CT scan. The CT scan range of venous phase CT was from the top of the intrahepatic IVC cephalad to tip of the toe caudally, which were reconstructed with 2.5 mm (mm) slice thickness. CT data was used to determine study measurements using a three dimensional workstation (AquariusNET, Terarecon, San Mateo, Calif). Two readers (OOO and OOO) reviewed measurements and assigned various measurement parameters. The filter tilt angle was determined by comparing the long axis of the filter and the long axis of the IVC. Filter tip abutment to the IVC wall was defined as the visual abutment of the hook of the IVC filter against the IVC wall (Fig. 2). Penetration of the filter tip was defined as the penetration of the IVC wall by the filter tip or their strut over 3 mm on axial CT image. And proximity of the filter to the renal vein was measured between the most caudal end of the filter to the lowest renal vein insertion on reconstructed CT data. Subgroup analysis of filter tip abutting and penetration was also performed. The possible causes of filter tip abutting or limb penetration to the IVC wall were postulated by CT image analysis.

2.4. Fluoroscopic time

Procedure time was estimated using the proxy of fluoroscopy time recorded on the last available imaging study. The entire fluoroscopic time during the procedure from the initiation of the procedure to the last imaging was used.

2.5. Statistical analysis

Continuous variables were analyzed using analysis of variance and categorical variables were compared using a Chi-square test for trends for the three different venous access methods. Statistical analysis was performed using MedCalc version 17.5 statistical software (MedCalc Software bvba, Ostend, Belgium) with a p value < 0.05 considered statistically significant.