Inferior Vena Cava Filter Insertion through The Popliteal Vein: Enabling The Percutaneous Endovenous Intervention of Deep Vein Thrombosis with A Single Venous Approach in A Single Session

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PURPOSE

To evaluate the efficiency of placing an inferior vena cava (IVC) filter through the same popliteal vein access site used for peripheral endovascular intervention (PEVI) in patients with extensive lower extremity deep vein thrombosis (DVT).

MATERIALS AND METHODS

Study population

We retrospectively analyzed the medical records of 21 patients who underwent IVC filter insertion via popliteal venous access between January 2012 and July 2015. Thirteen patients were women and 8 patients were men. The average age was 61.7 (range, 30-86 years).

IVC filter insertion

In all patients, a popliteal vein approach in the leg with the venous thrombosis was attempted. The ipsilateral popliteal vein puncture was done under ultrasonography guidance, with a micro-puncture set employing a 21-gauge needle (Cook Medical, Bloomington, IN, USA), and was followed by the insertion of an 8-Fr angiography introducer sheath (Radifocus; Terumo, Tokyo, Japan). A 5-Fr headhunter type angiographic catheter (Boston Scientific, Natick, MA, USA) was then introduced and passed through the venous segment containing the thrombosis. After the angiographic catheter was entered into the IVC lumen, a double-basket shaped retrievable IVC filter equipped with a 90cm length introducer set (OptEase filter; Cordis, Warren, NJ, USA) was introduced along stiff guide wire (Cook medical, Bloomington, IN, USA) and deployed in the infra-renal IVC under fluoroscopic guidance.

PEVI for DVT

After IVC filter insertion, endovascular treatment, including aspiration thrombectomy or thrombolysis, was performed for iliofemoral vein thromboses.

Measuring filter tilt

The filter tilt measurement was performed with 3-dimensional rendering software (Aquarius iNtuition viewer; Terarecon, SanMateo, CA, USA). After loading the follow-up CT venography (CTV) image data using this soft ware, multi-planar reformatted images, including the coronal and sagittal plane, were obtained. With this reconstructed image data, the filter tilt was measured in the coronal and sagittal planes (**Figure 1**).

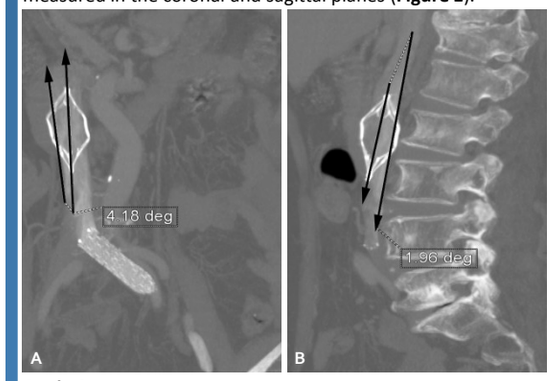

Figure 1. Measuring filter tilt.
A. Reconstructed coronal CT image shows the axis of the IVC filter, with a tilt angle of 4.18° (arrows = angle created by the axis of the filter with respect to the IVC).
B. Reconstructed sagittal CT image shows the axis of the IVC filter, with a tilt angle of 1.96° (arrows = angle created by the axis of the filter with respect to the IVC).

Analysis

To evaluate the efficacy of the trans-popliteal venous IVC filter insertion, we analyzed the degree of filter tilt in each patient. According to the Society of Interventional Radiology definition (1), significant filter tilt, regarded as an insertion problem, was defined as a filter tilt ≥ 15° from the IVC axis as seen in the coronal or sagittal plane. The success of filter removal was also evaluated to assess the ease of filter removal. A paired t-test was performed to compare the difference in filter tilt degree between the coronal and sagittal planes.

RESULTS

The mean DVT symptom duration for the enrolled patients was 4.01 ± 4.07 days (range, 5 hours – 14 days) (**Table**).

Seventeen patients showed thrombosis of the distal veins, such as the calf veins, as well as the proximal iliofemoral veins. In all patients, recanalization procedures (such as thrombectomy or catheter-directed thrombolysis) and IVC filter insertion for the prevention of pulmonary embolism (PE) were performed sequentially through a single popliteal vein access site. Aspiration thrombectomy (n=21) and catheter-directed thrombolysis (n=16) were performed to re-canalize the occluded lower extremity veins immediately after IVC filter deployment. For catheter-directed thrombolysis, urokinase was infused continuously for several hours (range, 1.5 – 4 hours, mean, 3.21 ± 0.95 hours) at 100,000 IU/h. The median amount of infused urokinase was 320,000 IU (range, 140,000 – 540,000 IU). Adjuvant endovascular treatment, including venous stent or balloon angioplasty in cases of flow-limiting venous pathology, was performed in 15 patients. There were no major complications during or after the procedure.

In all patients (n=21), OptEase filters were successfully deployed in the infra-renal IVC through the ipsilateral popliteal vein access site. Balloon angioplasty of iliac vein was necessary in one patient with severe iliac vein stenosis prior to filter deployment. Follow up CTV data were obtained in 17 patients within 2weeks of the procedure. The degree of filter tilt in each patient is listed in **Table**.

Patient	Age	Sex	Duration of Symptoms (days)	Predisposing Factors	Location of Thrombus	Preprocedural D-dimer (mg/L)	Coronal Tilt Angle (degrees)	Sagittal Tilt Angle (degrees)
1	63	F	0.5	Unknown	Both	13.95	3.4	5.4
2	72	F	5	Immobilization	Left	6.68	-*	-
3	69	F	7	May-Thurner syndrome	Left	27.17	11.7	5.75
4	57	F	0.2	May-Thurner syndrome	Left	27.09	-	-
5	63	M	7	Unknown	Left	6.31	8.4	5.8
6	36	F	7	Immobilization	Left	5.01	7.17	14.3
7	77	M	0.2	Immobilization	Left	8.82	2.58	5.73
8	78	F	0.3	May-Thurner syndrome	Left	Not checked	0	13.1
9	71	F	1	May-Thurner syndrome	Left	Not checked	14.3	16.5
10	65	M	1	May-Thurner syndrome	Left	Not checked	6.6	4.81
11	30	F	1	May-Thurner syndrome	Left	2.6	13.4	15.1
12	86	M	14	May-Thurner syndrome	Left	5.45	10.4	9.2
13	66	F	14	Malignancy	Left	10.46	-	-
14	48	M	4	Behcet disease	Left	0.42	7.86	18
15	79	M	1	Previous operation	Right	2.73	-	-
16	34	M	3	Immobilization	Left	8.76	9.31	1
17	55	F	5	May-Thurner syndrome	Left	4.4	2.3	2.82
18	75	F	4	May-Thurner syndrome	Left	6.1	4.18	1.96
19	55	M	1	Immobilization	Both	Not checked	4.25	11.3
20	65	F	3	May-Thurner syndrome	Left	5.74	13.5	13.9
21	52	F	5	Malignancy	Left	7.87	2.09	4.38

* Follow up CT venography was not performed in 4 patients.

Table. Patient Characteristics and Degrees of Filter Tilt.

The measured mean filter tilt was 7.14 ± 4.48° in the coronal plane and 8.77 ± 5.49° in the sagittal plane. Although the sagittal filter tilt was larger than the coronal filter tilt, this difference was not statistically significant (P = 0.238, paired t-test). Considerable filter tilt, defined as tilt ≥ 15°, was observed in 3 patients, and maximal filter tilt was 18° (**Figure 2**).

Figure 2. Significant filter tilt.
A. Reconstructed coronal CT image shows the axis of the IVC filter with a tilt angle of 7.86° (arrows = angle created by the axis of the filter with respect to the IVC).
B. Reconstructed sagittal CT image shows the axis of the IVC filter, with a tilt angle of 18° (arrows = angle created by the axis of the filter with respect to the IVC).

Filter retrieval was attempted in 17/21 patients. The reason for permanent filter placement was persistent DVT in three patients and patient refusal of the retrieval procedure in one patient. In 16 patients, the OptEase filter was successfully removed after a mean filter dwell time of 20.13 days. The longest filter dwell time was 37 days. In one patient, the filter could not be removed because the caudal hook of the filter was embedded into the IVC wall: the sagittal tilt of filter of this patient was 14.3°.

DISCUSSION

In general, the IVC filter is inserted several days prior to thrombolytic therapy. This is done because if these two procedures are performed on the same day, bleeding may occur at access site of filter insertion, which is typically the femoral or internal jugular vein. However, in this study, all filters were placed using the same popliteal access site used for PEVI, thereby avoiding the need for patient repositioning. Using the same access site allows filter placement and PEVI to be performed sequentially in a single procedure. The OptEase filter has a 6 Fr system with a 90 cm-long introducer sheath, allowing insertion of the filter from the popliteal vein into the infrarenal IVC. In our experience, all OptEase filter insertions through the popliteal vein access site were successful. Furthermore, a same-day or single-session procedure can decrease the length of time that the filter is in place. The incidence of complications associated with IVC filters is time dependent. Recent data from a systematic review of 37 studies confirmed the increased rate of complications when filters are left in place for ≥ 30 days and reported a retrieval rate of approximately 34% (2). The risks of unretrieved filters include recurrent DVT, vena cava thrombosis, organ penetration, and mechanical filter complications such as migration and strut fracture.

The transpopliteal insertion of an IVC filter carries the potential risk of filter tilt. Excessive tilt of the filter during placement may increase the risk of ineffective thrombus filtering, perifilter thrombosis, and retrieval failure and may also promote vascular remodeling (3). Retrieving filters that are tilted requires a longer procedure, increases radiation exposure, and may increase the overall risk of complications. In our study, significant filter tilt occurred in three (14.3%) patients, which is less than or equal to the tilt rates reported in other published studies (4). With these relatively low tilt rates, our rate of filter retrieval was 76.2%, which is higher than that reported in other published studies (5-6). Filter retrieval was successful in 16/17 patients (94.1%) in whom filter retrieval was attempted. In one patient, the filter could not be removed because the caudal hook of the filter was embedded into the IVC wall.

There are some limitations in this study. First, filter placement through the ipsilateral popliteal vein has a potential risk of iatrogenic PE because the filter delivery system may be passed through the sites of thrombus formation. However, the relatively small 6 Fr system of the OptEase filter, along with gentle manipulation during filter insertion, can reduce the risk of iatrogenic PE. In this study, none of the patients experienced symptomatic PE. Although we feel that this procedure is associated with a relatively low risk for iatrogenic PE, future studies using post procedural multidetector CT of the pulmonary arteries or ventilation/perfusion scintigraphy are required to further assess the risk of iatrogenic PE. Second, this study is limited in that it may not be generalizable because this was a single-institution experience.

CONCLUSIONS

In conclusion, our study suggests that popliteal vein IVC filter insertion is an efficient procedure that can be performed in conjunction with PEVI in a single session through a single site. This method is also associated with a low occurrence of significant filter tilt.

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