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Filter tilting and retrievability of the Celect and Denali inferior vena cava filters using propensity score-matching analysis

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ABSTRACT

Purpose: To assess the filter tilting and outcomes of the Celect and Denali inferior vena cava (IVC) filters by using a propensity score-matching analysis.

Materials and methods: From January 2009 to November 2017, 181 Celect and 58 Denali filters were inserted in our institution. To assess filter tilt, filter tip abutment or penetration of the IVC wall, and retrieval outcome, independent variables, including age, sex, IVC long diameter, IVC angulation, and proximity of the filter to renal vein insertion, were entered in the propensity model. Comparative analyses were performed before and after propensity score-matching analysis.

Results: Thirty-one patients were enrolled in each group for the final propensity score-matching analysis. The mean filter indwelling time was not significantly different between the groups (26 ± 22 days in Celect and 27 ± 23 days in Denali). After propensity score adjustment, the mean degree of filter tilt was higher in the Celect group (9.5° ± 7.4° vs 5.6° ± 6.7°). Filter tip abutment or penetration of the IVC wall was more common in the Celect group (39% [12/31, abutment: 12, penetration: 0] vs 13% [4/31, abutment: 3, penetration: 1]). The retrieval outcomes were not significantly different before and after propensity score adjustment in both filters.

Conclusion: The Denali IVC filter showed less tilt and low rate of filter tip abutment to the IVC wall after propensity score-matching analysis. The retrieval rate was not significantly different in the short-term filter indwelling setting. More large-scale, long-term follow-up studies are needed to verify these results.

1. Introduction

Retrievable inferior vena cava (IVC) filters have been widely used to prevent life-threatening pulmonary thromboembolisms resulting from acute deep-vein thrombosis in patients contraindicated for anticoagulation therapy [1,2]. Over time, IVC filter designs have been modified, and filters with less tilt and higher retrieval rates are being developed. However, the retrieval failure or difficult retrieval is still a problem, and the main reasons are considered as filter-tip epithelialization or incorporation of the filter struts into the caval wall caused by filter tilt and long indwelling time of the filter [3,4].

Previously, conical-shaped with unique strut designed filters such as the Celect IVC filter (Cook Medical, Bloomington, Ind, USA) were widely used; however, many studies have shown filter tilting and its related problems [3–5]. Recently, the Denali IVC filter (Bard, Peripheral Vascular, Temte, AZ, USA) was introduced, which additionally added shoulder parts in the filter arms to prevent filter tilting, and showed favorable safety and a high retrieval rate [5,6].

Few studies have compared the widely used Celect IVC filter and the recently developed Denali filter [5,7]. However, various confounding factors exist in comparisons of the safety and outcomes of two different filters, such as patient age, sex, IVC diameter and angulation, and proximity to renal vein. To date, no study has accounted for these confounding factors in their comparison between Celect and Denali IVC filters. Therefore, in this study, we used a propensity score-matching statistical technique to eliminate these various biases and compare the filter tilting and outcomes between these two filters.

Abbreviations: IVC, inferior vena cava; PACS, picture archiving and communication system; CT, computed tomography; 3D, three-dimensional

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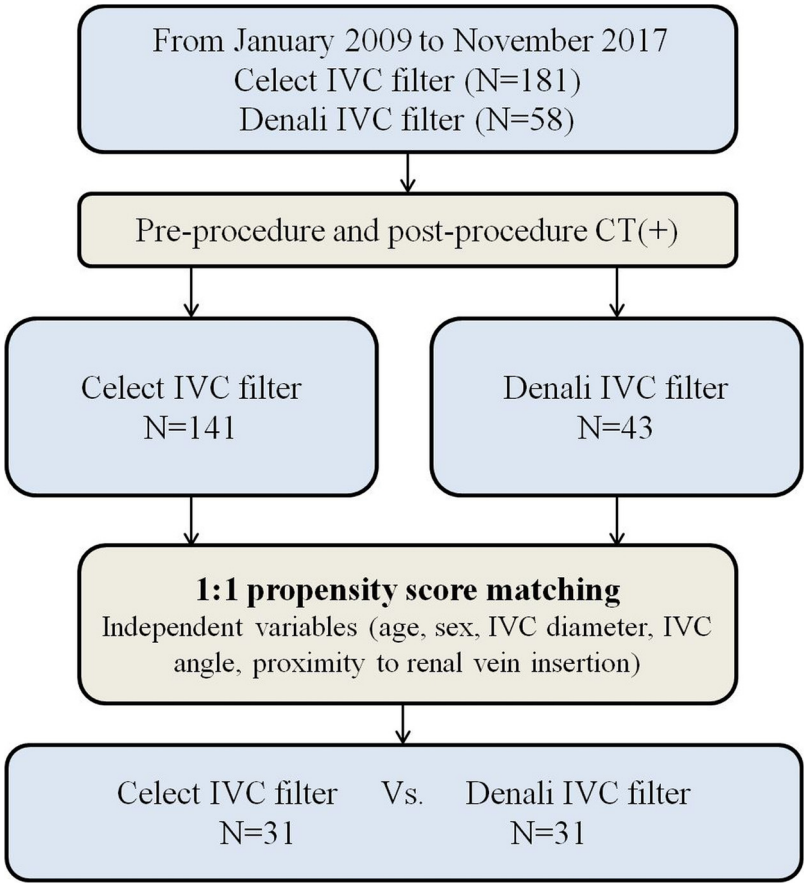

Fig. 1. Flow chart shows patient enrollment of this study.

2. Materials and methods

2.1. Patients

Our institutional review board approved this retrospective case-comparative study. Patient informed consent was waived. To compare filter tilt and retrieval rate between the two different IVC filters, cases were retrospectively collected using the electronic medical chart and picture archiving and communication system (PACS). From January 2009 to November 2017, 181 Celect IVC filters and 58 Denali IVC filters were inserted in our institution. The patient enrollment and exclusion criteria are shown in Fig. 1.

2.2. IVC filter insertion and retrieval

All filters were inserted for patients temporarily or permanently contraindicated to undergo anticoagulation therapy for thromboembolic disease. All procedures of Celect filter insertion and retrieval were performed by one experienced radiologist who had > 5 years of experience in interventional radiology at the study initiation time. All Denali IVC filters are inserted by an interventional radiologist with more than 2 year experience. For IVC filter insertion, the patients were moved to the angiographic suite. After skin anesthesia with 2% Lidocaine, ultrasonography-guided venous puncture was performed. The venous access sites were various for example, right internal jugular, right femoral, or left femoral vein. An inferior venacavogram was acquired to identify the renal vein insertion level and the vena caval anatomy. The catheter/sheath tip was located at lowest position of the IVC and 20 ml of contrast media was manually injected under anterioposterior projection distal subtraction angiography with full inspiration. Then the IVC filter was gently unsheathed and deployed. All filters were deployed in the infrarenal IVC. After deployment, repeated cavography was performed to confirm the position of the filter.

All IVC filter removals were routinely attempted using a right internal jugular venous access with the usual endovascular snare technique. To compare the retrieval rate and safety of the two different IVC filters, we assessed the filter retrieval attempt, success rate, and procedure-related complications, and applied the advanced retrieval technique, which required devices other than the usual snare technique.

2.3. Measurements of imaging data

All the enrolled patients had a pre-filter insertion and pre-filter retrieval venous-phase computed tomography (CT). The pre-filter retrieval CT scans were conducted for evaluation of filter retrievability or follow-up of deep vein thrombosis/pulmonary thromboembolism. All CT scans were performed using the deep-inspiration breath-hold technique. The CT protocol was combining the CT pulmonary arteriography and venography of abdomen and lower extremity. All enrolled patients underwent multidetector contrast enhanced CT using a variety of multidetector CT scanners – Lightspeed 16, Optima 660, Revolution EVO (GE Healthcare, Milwaukee, WI), and SOMATOM Force (Siemens Health Care, Forchheim, Germany). CT pulmonary arteriography followed after intravenous administration of a weight- and scanner-based dose of 80–100 mL Omnipaque 350 (GE Health Care, Seoul, Korea) with an injection rate of 1.5–2 mL/second. After 110 s delay, abdominal and lower extremity venous phase CT were taken. Various image parameters were measured on pre-filter insertion and pre-filter retrieval venous-phase CT. The mean interval between the pre-filter insertion CT and filter insertion was 5 ± 23 days, and that between the filter insertion and pre-filter retrieval CT was 64 ± 151 days. Filter tilt angle, filter tip abutment or penetration of the IVC wall, IVC angle, and