Fractured Bard Recovery, G2, and G2 Express Inferior Vena Cava Filters: Incidence, Clinical Consequences, and Outcomes of Removal Attempts

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ABSTRACT

Purpose: To increase the understanding of risks of inferior vena cava (IVC) filter fracture and embolization and the safety of removing fractured filters via retrospective review of a prospectively collected database of fractured IVC filters.

Materials and Methods: A total of 63 fractured IVC filters were discovered among 548 patients presenting for retrievable filter removal between April 2004 and November 2010 at a single institution. Device type, duration of implantation, component fracture, and embolization events were recorded. Success rates and techniques for removal of components were recorded.

Results: A total of 63 fractured Recovery, G2, and G2 Express IVC filters were identified, for an overall fracture rate of 12%. Excluding foot process fractures, the fracture rate for only filter arms and/or legs was 6%. The incidence of fracture increased with longer filter dwell times. Success rates for removal of the nonfractured component (ie, main body) and fractured components (ie, arm or leg) were 98.4% and 53.4%, respectively. The distal embolization rate of fractured filter components was 13%. There were no immediate clinically significant complications associated with fracture component embolization or filter removal. A single patient was encountered with symptoms related to their fractured filter.

Conclusions: IVC filter fracture rates increase with longer dwell times; however, removal of fractured filters and fractured components (ie, arms and legs) can be achieved safely and effectively. Clinically significant complications of IVC filter fracture are rare, and there were no immediate clinical sequelae related to embolization of fracture components.

ABBREVIATIONS

IVC = inferior vena cava, SNF = Simon Nitinol filter

Inferior vena cava (IVC) filter fracture is a known risk of long-term filter implantation, with rates reported with great variability from 2% to 25% (1–3). Recent case reports have discussed rare but severe complications involving embolization of fractured elements to the right ventricle (2,4–7), resulting in cardiac tamponade and ventricular arrhythmia. Other potential embolic sites include the pulmonary arteries. Alternatively, fragments may remain stationary, becoming incorporated into the IVC or retroperitoneum (2,4). Nonembolized fragments or those embolized to the pulmonary arteries may be of lesser clinical consequence; however, there are few data to support the long-term consequences of these phenomena.

Removal of fractured IVC filters and their components has been reported in the setting of complications (4–7). To our knowledge, no criteria have been set forth for the nonemergent management of fractured retrievable IVC filters discovered at the time of removal or incidentally during the implantation period. This retrospective review of a prospectively collected database of fractured IVC filters

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was performed with the intent to increase the understanding of the incidence of IVC filter fracture, the clinical consequences of IVC filter fracture, and the safety of removing fractured IVC filters.

MATERIALS AND METHODS

After approval from the local institutional review board was obtained, patients with IVC filter fracture discovered at the time of presentation for filter removal were identified from a retrospective review of a prospectively collected database of all patients undergoing retrievable IVC filter removal at a single institution between April 2004 and November 2010. Patient identifiers were removed to protect patient confidentiality. Chart and picture archiving and communication system image review were performed, and data recorded to include filter model, implant date, implant indication, patient sex, patient age at implantation, explantation date, implant dwell time, component fractured, removal technique, postremoval flush cavography, and postremoval visual inspection of the filter. Filter fractures were classified as foot process, arm, or leg fracture. The main portion of the filter from which these components were separated is described as the main body of the filter. Statistical analysis was performed by using Excel (Microsoft, Redmond, Washington).

Our technique for IVC filter removal has been previously described (8,9). Magnified and nonmagnified fluoroscopic and spot magnification inspection of all filters was performed before any manipulation to evaluate filter position, orientation, and integrity. Flush cavography with digital subtraction angiography was performed to document absence of filter thrombus. Flush cavography was most often performed in a single plane. However, in the presence of partial incorporation of the filter or fractured components into the caval wall, additional oblique flush cavograms were obtained to better delineate which portions of the filter or fragments were accessible for intraluminal capture. Fractured filters within the study included Recovery, G2, and G2 Express filters (Bard Peripheral Vascular, Tempe, Arizona). Removal attempts were first made by using standard techniques. For Recovery and G2 filters, a standard cone removal technique was employed by using the Recovery Cone system (Bard Peripheral Vascular). For G2 Express filters, a standard snare technique was employed. When standard techniques failed, other techniques were used to remove the filter, including balloon assistance (10) (n = 1), loop snare techniques (11) (n = 9), and the use of rigid endobronchial forceps (12,13) (n = 3). A combination of several techniques was frequently required. Fractured IVC filter removal technique data are summarized in **Table 1**.

Filters were routinely visually inspected after removal to evaluate for fracture or clot. Follow-up flush cavograms in a single anteroposterior plane were obtained through the existing sheath after IVC filter removal. Additional oblique flush cavograms were obtained when fractured elements were thought to be partially or completely incorporated into the caval wall. In the event that a fractured component could not be localized, fluoroscopic and spot magnification inspection of the chest and abdomen was performed in attempt to localize fractured components.

Table 1. Primary Technique Used for Fractured IVC Filter Retrieval

Filter	Recovery Cone	Simple Snare	Modified Loop Snare	Bronchoscopy Forceps
Recovery	12	0	0	0
G2	35	1	4	1
G2 Express	0	7	2	1
Total (%)	47 (75)	8 (13)	6 (9)	2 (3)

Note.—Values in parentheses are percentages. IVC = inferior vena cava.

If the retained fractured filter fragments were easily accessible and not incorporated into the caval wall, attempts were made to percutaneously remove them. At the conclusion of the procedure, patients were notified if their filter was fractured and if fractured components were not retrieved. If unretrieved filter elements remained, the risks associated with these were always discussed with the patient. In general, patients were counseled that the unretrieved fragments were unlikely to be of clinical consequence. However, potential embolic risks and associated symptoms were always discussed.

RESULTS

Between April 2004 and November 2010, a total of 548 patients presented for IVC filter retrieval. All filters in the study were removed by interventional radiology personnel, and all but five of these filters were placed at the study institution. The remaining filters were placed at outside institutions. Indications for filter placement included trauma, intracranial hemorrhage, perioperative prophylaxis, documented deep vein thrombosis in a patient deemed to be at high risk, or documented pulmonary embolism.

A total of 63 fractured filters (12%) with 77 component fractures were identified. Fractures involved 12 Recovery, 41 G2, and 10 G2 Express filters. These included the five filters placed at outside institutions, including three Recovery and three G2 filters. One patient had two G2 filters placed at an outside institution. In that patient, the second filter was placed above the first after the first filter was maldeployed. At the time of removal, both these filters were fractured (**Fig 1**).

There were 33 filters (6%) with fractured foot processes, with 32 involving a single foot process and one involving two foot processes, for a total of 34 foot process fractures (**Fig 2**). There were 32 filters (6%) with fractured arms and/or legs, including 17 with one fractured arm, three