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Original Article

Radiology Section

The Role of Potentially Retrievable Inferior Vena Cava Filters in High-Risk Patients Undergoing Joint Arthroplasty

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ABSTRACT

Introduction: Some patients undergoing total joint arthroplasty are at increased risk for venous thromboembolism (VTE). The aim of the present study was to evaluate the safety and efficacy of prIVCF in preventing PE in patients undergoing joint replacement surgery who are at high-risk for VTE.

Materials and Methods: In this prospective, IRB-approved study, prIVCF were placed in consecutive patients who met specific high-risk criteria (history of VTE or hypercoaguable state) prior to total joint arthroplasty. Patients were followed until the IVC filter was removed. Outcomes and complications were recorded per Society of Interventional Radiology guidelines.

Results: One hundred and nine potentially retrievable IVC filters were placed in 105 patients, who all subsequently underwent joint arthroplasty. One hundred eight IVC filters (98.9%) were retrieved successfully in a mean time of 44.1 days (range 13-183 days). There was 1 failed IVC filter retrieval attempt (0.9%) at 46 days post implantation. Two patients (1.9%) presented with recurrent PE and were successfully treated with anticoagulation prior to IVC filter retrieval. There were no fatalities from perioperative PE. In 1 patient (0.9%), a fractured filter leg had embolized during retrieval.

Conclusion: Potentially retrievable IVC filters are safe and effective for prophylaxis against PE in patients at high-risk for VTE undergoing joint arthroplasty.

Keywords: Deep venous thrombosis, Prophylaxis, Pulmonary embolism, Safety, Venous thromboembolism

INTRODUCTION

Acute pulmonary embolism (PE) has been reported in up to 28% of patients undergoing total joint arthroplasty [1,2]. Current standard of care for perioperative prophylaxis against a venous thromboembolic event (VTE) includes both mechanical (i.e. pneumatic stockings) and pharmacologic (i.e. systemic anticoagulation) methods, which have substantially reduced the morbidity and mortality rate in the general orthopedic population [1-4]. However, surgical candidates who have pre-existing risk factors for VTE, such as those with documented history of PE, acute deep vein thrombosis (DVT), or hypercoagulable state, represent a clinical challenge as their risk of VTE increases in the perioperative setting.

Inferior vena cava filters offer a mechanical means of preventing DVT from propagating to the lungs, mitigating the risk of potentially fatal pulmonary embolism (PE). Historically, these devices were permanent; once placed, IVC filters were left in place for the lifetime of the patient. Newer generations of mechanical prophylaxis, potentially retrievable inferior vena cava filters (prIVCF), is now available and appears effective in preventing PE in patients with known VTE disease unable to undergo primary anticoagulation. In this study, we aim to evaluate the safety and efficacy of prIVCF in preventing PE in patients undergoing joint replacement surgery who are at high-risk for VTE.

MATERIALS AND METHODS

Study Population

This Institutional Review Board-approved study was performed at an academic tertiary center from February 2011 to August 2014. Data were prospectively collected on patients deemed high risk for VTE scheduled to undergo joint replacement surgery, which was performed primarily for advanced joint osteoarthritis. Inclusion criteria were age greater than 18 y, ability to consent for the procedure, and having one of the following high-risk factors for the development of VTE: history of PE, prior or acute deep venous thrombosis (DVT), or known pro-thrombotic disease. Exclusion criteria included occlusion of the internal jugular veins precluding subsequent retrieval of the inferior vena cava (IVC) filter, IVC occlusion, underlying medical conditions with a less than 6-month life expectancy, and acute sepsis or severe infection.

Filter Placement and Retrieval

Four types of commercially available prIVCF were placed at our institution during the study period: the Celect filter (Cook, Bloomington, Indiana), the Option filter (Rex Medical, Conshohocken, Pennsylvania), the Günther Tulip filter (Cook Medical, Bloomington, Indiana), and the Denali filter (Bard Medical, Murray Hill, New Jersey). The type of filter placed was at the discretion of the interventional radiologist performing the procedure. Potentially retrievable IVC filters were placed in all patients in the IR angiography suite, as described elsewhere [5], and then patients were transferred to the pre-operative area for those undergoing same day surgery. Patients whose surgery was planned for a future date were discharged one hour following the outpatient procedure and returned on the day of their scheduled surgery. Patients subsequently underwent joint arthroplasty with perioperative VTE prophylaxis per the orthopedic surgery department standard protocol. Once the patient fully recovered from surgery and the VTE risk was judged to have returned to baseline level by the orthopedic surgeon, IVC filter retrieval was scheduled and performed as described previously [5]. For patients undergoing bilateral total joint arthroplasty or revision of a primary arthroplasty several months after the initial surgery, a second IVC filter was placed with the same protocolat that time. These filter placements were intentionally staged in this fashion to prevent endothelialization of the IVC filter to the wall of the IVC. This physiologic phenomenon occurs over the course of time so that longer IVC filter dwell times correlate with more difficulty removing the IVC filter [6,7].

Data Collection

Data were collected according to the Society of Interventional Radiology (SIR) reporting standards for IVC filter placement and follow-up [8-10]. As noted in these guidelines, technical success

of filter implantation was defined as placement of the IVC filter with proper positioning, and technical success of filter retrieval was defined as complete removal of the filter. At the time of filter placement, IVC findings (i.e. variant anatomy), filter type, and filter placement were verified and recorded by the interventional radiologist performing the procedure. After placement, each patient was followed in order to determine 1) an appropriate time for filter removal; and 2) to note any unexpected office and/or hospital visits, including the occurrence of PE [5]. At the time of filter retrieval, the interventional radiologist recorded filter position and any associated complications. The endpoint of this study was successful or unsuccessful retrieval of the filter.

RESULTS

One hundred and nine prIVCFs were placed prior to joint replacement surgery in 105 consecutive patients. Four patients (3.8%) underwent intentional staging of two filter placements for bilateral arthroplasty or primary arthroplasty revision. The mean patient age in our study was 63.6 y (range 25-84 y), and a total of 92 patients had a history of PE and/or DVT (87.6%). A summary of patient demographics is recorded in [Table/Fig-1]. Technical success of filter implantation was achieved in all patients (100%), with a total of 84 Celect IVC filters (Cook Medical, Bloomington, Indiana), 18 Option IVC filters (Rex Medical, Conshohocken, Pennsylvania), 5Günther Tulip filters (Cook Medical, Bloomington, Indiana), and 2 Denali filters (Bard Medical, Murray Hill, New Jersey) placed.

Variable	Number (percent of total)
Patients	105
Age (yr, mean)	63.6 (range 25-84)
Male	45 (42.9%)
Female	60 (57.1%)
Risk Factor for VTE	
Documented PE only	35 (33.3%)
Documented DVT only	22 (21%)
Documented PE and DVT	35 (33.3%)
Pro-thrombotic disease	11 (10.4%)
IVC Filters	109
Celect	84 (77.1%)
Option	18 (16.5%)
GüntherTulip	5 (4.6%)
Denali	2 (1.8%)
Total Joint Arthroplasties	110*
Knee	54 (49.1%)
Hip	56 (50.9%)
Indication for Arthroplasty	
Advanced Osteoarthritis	96 (87.2%)
Arthroplasty Revision	7(6.4%)
Avascular Necrosis	6 (5.5%)
Trauma	1 (0.9%)

[Table/Fig-1]: Characteristics of High-Risk Patients undergoing Prophylactic IVC Filter Placement Before Total Joint Arthroplasty
* One patient received bilateral knee arthroplasties after a single filter placement, while two other patients received intentionally staged filter placements for planned bilateral arthroplasty procedures.
VTE = venous thromboembolism, DVT = deep venous thrombosis, PE = pulmonary embolism

Seventy-two patients (68.5%) had IVC filter placement the same day of surgery, with the mean time from prIVCF placement to orthopedic surgery being 0.8 days (range 0-13 days). All patients who had IVC filters placed subsequently underwent joint arthroplasty. A total of 110 total joint arthroplasties were performed throughout this study (56 hips and 54 knees). Of these, one patient received a single filter placement before an expedited bilateral joint arthroplasty, resulting in 109 total filters throughout the study. Primary arthroplasty was performed for 100 joints (91%), with advanced osteoarthritis as the most common indication (96/110, 87.2%).

All patients presented for IVC filter retrieval, with none lost to follow-up. The mean time from prIVCF placement to retrieval was 44.1days (range 13-183 days). Technical success of IVC filter retrieval was achieved in 108/109 cases (99%). The one failed filter retrieval was attempted 46 days after placement.

No patient death occurred throughout the study; specifically, no patient died of PE following joint arthroplasty. However, two patients experienced symptomatic PE following IVC filter placement and joint arthroplasty (1.9%): a 77-year-old female with history of bilateral segmental PE who underwent revision of her left TKA; and a 55-year-old female who received a prophylactic filter for a left hip arthroplasty and could not tolerate anticoagulation therapy secondary to underlying coagulopathy. Both patients presented with mild dyspnea approximately one month after their respective orthopedic surgeries. The diagnosis of acute sub-segmental PE was made with contrast enhanced computed tomography (CT) of the chest. Both patients were treated successfully with therapeutic anticoagulation without further adverse sequelae.

Additionally, the 77-year-old female who had a recurrent PE also sustained a filter fracture during retrieval. Fifty-eight days after filter placement, she presented to an outside hospital for retrieval; at that time, a strut of the IVC filter fractured during the retrieval process and was presumed to be extra-vascular. A week later, however, the patient returned to the hospital with hemopericardium and cardiac tamponade, requiring thoracotomy for filter fragment retrieval from the right ventricle. The patient was ultimately discharged from the hospital following recovery from this surgery. At the time of retrieval, thrombus encompassing less than 10% of the filter cone was identified in 2 IVC filters (1.8%), which did not prevent filter retrieval. However, in two other cases (1.8%), a significant amount of thrombus (greater than 25% volume of the filter cone) was present, and treatment with anticoagulation was performed for one month prior to subsequent successful IVC filter retrieval. No adverse clinical sequelae were identified.

DISCUSSION

This study demonstrates the safety and efficacy of potentially retrievable IVC filters for patients at an increased risk for VTE undergoing joint arthroplasty. While two patients (1.9%) did present with recurrent sub-segmental PE after filter placement, none resulted in death and both cases were treated successfully with anticoagulation. Four filters (3.7%) in our study had thrombus at the time of retrieval, which were all successfully retrieved. The origin of this thrombus is likely related to expected filter function: trapping clot that would have otherwise propagated to the pulmonary arteries, which may have resulted in a higher number of patients in our study experiencing PE. The rate of PE in our study is comparable to existing literature for permanent filter placement, which ranges from 0.5%-6.5% [11,12] despite the fact that our study population was at a very high risk for VTE secondary to their perioperative state and underlying comorbidities. Indeed, over 85% of patients in our study had documented PE and/or DVT and were undergoing a surgery resulting in a higher risk of venous thromboembolic disease [13]. Past studies report a rate of 0.2-1.4% of PE following joint arthroplasty in patients with chemoprophylaxis, but these cohorts include a broad range of patients, most of which do not have a history of DVT, PE, or other co-morbid conditions that would contribute to an even higher risk of VTE [14]. Although no studies have described the exact incidence of PE in this specific high risk orthopedic population as in our study population. White et al., showed that patients with a prior history of thromboembolism more than doubled their risk of rehospitalization for symptomatic VTE after joint arthroplasty [15].

The PREPIC study demonstrated strong evidence for the effectiveness of permanent IVC filters for preventing acute PE: patients with IVC filters had a lower rate of PE at both short-term and long-term follow-up compared to patients receiving anticoagulation alone [16]. However, the study also raised a potential long-term risk with IVC filters, as there was an increased incidence of DVT identified eight years after IVC filter placement. Since the risk of VTE is transiently increased in the perioperative period, prIVCF may provide effective prophylaxis, while avoiding potential long-term complications of device placement.

The use of both permanent and prIVCF for VTE prophylaxis for high-risk surgical patients has been well-documented in those undergoing bariatric and spinal procedures [17-20]. However, in the orthopedic population, only permanent IVC filters have been investigated. These studies have shown that the use of permanent IVC filters can be effective in preventing fatal postoperative thromboembolic events [21-24]. For example, Austin et al., described prevention of fatal PE in 95 patients undergoing joint arthroplasties after placement of two different types of permanent devices. In that study, only two patients (2.1%) suffered from a recurrent PE, none resulting in death [21]. None of the studies investigated the potential risk of long-term device placement. Filter fracture has been reported with great variability, ranging from 0-25%. The fractured struts may remain stationary within the IVC wall or retroperitoneum, or, less commonly, may embolize to the heart or pulmonary arteries, resulting in perforation, as in our patient [25-29]. Other potential complications related to IVC filters that were not experienced in our study population include significant filter tilt (5-24%), IVC occlusion (0-12.5%), and filter migration (0-4%) [12,25,30,31].

LIMITATIONS

This study has several important limitations. First, our cohort is relatively small with a total of 109IVC filters, which does not limit the possibility of sample error. Second, no comparison group was present in the study to directly compare the rates of patients undergoing similar high-risk elective procedures without an IVC filter implanted. Our orthopedic surgery colleagues do not operate on these high-risk patients without an IVC filter in place. Third, more than one type of prIVCF was evaluated in this prospective study; however, this was allowed such that this study would represent standard clinical practice, as there is no conclusive evidence to support that one device is superior to another. Finally, our study does not investigate theoretical long-term consequences of optional filter retrieval, such as potential damage to the IVC wall or increased risk of DVT.

CONCLUSION

Our study demonstrates that prophylactic placement of potentially retrievable IVC filters can be effective in preventing PE in high-risk patients undergoing joint arthroplasty. These filters can provide protection against manifestations of VTE in the immediate postoperative period, when the risk of PE is highest, and they can be successfully removed, potentially decreasing long-term filter-related complications, such as DVT. These prIVCFs are associated with a low complication rate in our study, confirming the safety of these devices. Use of potentially retrievable IVC filters should be considered in patients with existing high risk factors for perioperative VTE undergoing joint arthroplasty.

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