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Byrd sheaths for complex inferior vena cava filter retrieval: Results of a preliminary study

Short title: Byrd sheaths for IVCF retrieval

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INTRODUCTION

Inferior vena cava filters (IVCF) are indicated as a preventive treatment of pulmonary embolism in high-risk patients (e.g., with failed or absolute contraindication to pharmacological anticoagulation, venous thromboembolism, poor cardiopulmonary reserve) [1, 2]. Introduction of retrievable IVCF and its approval for various elective indications led to a significant rise in filter placement in the early 2000s [3]. The downside of the IVCF expansion is the fact that long-indwelling filters are associated with many potential complications including both thrombotic and non-thrombotic events as well as vessel injury [4, 5]. That is why, it is recommended to remove the IVCF as soon as they are no longer indicated, particularly in younger patients. All this led to gradual decrease in filter utilization and trend to retrieve long indwelling retrievable filters [6].

Although a majority of IVCF can be removed without difficulty, in some cases (embedded hooks, filter penetration into the vessel wall or severe filter tilt) the removal might be particularly challenging. In order to improve retrieval success among patients with embedded

filters several advanced methods have been proposed [7,8]. Recently, Kuo et al. published a study conducted on 500 patients which proved that excimer laser sheath technique is safe and effective in removing almost of types and lengths of embedded IVCF [9]. In 2022, Yu et al. compared this method to forceps-assisted IVCF removal and observed that whereas the use of laser is associated with higher retrieval rate there are no significant differences in terms of procedural safety [10].

Byrd sheaths which are commonly used in pacemaker lead extraction might be an alternative device for dissecting and removal of embedded IVCF, especially in countries where excimer laser sheaths are not allowed for ICVF retrieval [11]. The aim of this report is to present our preliminary results with Byrd-assisted removal of embedded IVCF.

METHODS

This study involved trauma patients who underwent prophylactic implantation of retrievable OptEase inferior vena cava filter (Cordis Corporation, Miami Lakes, FL, US) in the prevention of pulmonary embolism and were afterwards referred for filter retrieval from 2019 to 2022. During this period disruptions in nonemergency medical care access and delivery were observed due to the COVID-19 pandemic which resulted in increased rate of patients with prolonged indwelling IVCF. The study group comprised the patients in which Byrd sheaths (Byrd Dilator Sheath Polypropylene, Cook Medical, Cook Inc., Bloomington, IN, US) were used in order to remove IVCF. In all cases initial retrieval was attempted in local anesthesia from a femoral approach using ‘‘snare and sheath’’ technique after cavography excluding the presence of intrafilter thrombi. Decision of Byrd dilatators’ application was made either after inability to sheathe the filter after multiple attempts or patient’s complaints of pain due to applied force. The size of used Byrd sheaths varied from 10 F to 16 F. Byrd sheaths were gradually advanced over the guidewire in order to peel the adhesion tissue surrounding the IVCF. Once it was achieved, the filter was withdrawn via the femoral vein. In all cases control cavography was performed. Procedural details, complication rates and overall retrieval rate was assessed. Minor complications included abdominal pain and transient IVC stenosis. Major complications were defined as IVC walls rupture or permanent vessel stenosis.

All patients gave their informed consent to participate in the study and the institutional review board approved it.

Statistical analysis

All statistical analyses were conducted using StatSoft Statistica 13.1 package. Data were presented as mean and range for continuous variables and as counts and percentage for categorical variables.

RESULTS AND DISCUSSION

In total 10 trauma patients were enrolled for the study. From this group 4 patients were female (40%) and the mean age of the patients was 42 years (ranging from 23 to 65; mean [standard deviation [SD], 12.6). Mean time from filter's implantation to removal was 121 days (range from 31 to 260; SD, 70.1). Initial procedure was successful in 7 patients (70%). Three patients reported abdominal pain and were scheduled for secondary procedure in conscious sedation. From this group the retrieval was successful in further 2 cases which resulted in overall procedural success rate of 90% (9/10 patients). In 1 case the procedure was unsuccessful and the patient was instructed about lifetime anticoagulation regiment. No major complications were noted. In terms of minor complications, abdominal pain was reported in previously mentioned 3 cases (30%) and mild IVC stenosis was found at the site of the removed filter in 2 patients (20%). In these cases, antiplatelet therapy was recommended for 3-4 weeks and control cavography was performed after this period. No residual stenosis was observed in follow-up examination (Figure 1).

Whereas the majority of retrievable IVCF are cone-shaped and are being removed from jugular access, the Optease is a diamond-shaped filter that is retrieved from femoral access. Because of the filter's structure and its adherence to the caval wall it is recommended to retrieve it earlier than conical filters. According to Rimon et al. recommended retrieval times for the conical filters range from 59 to 140 days on average whereas removal of Optease filters should be performed within first few weeks after implantation [12]. Rosenthal et al. recommended repositioning of the Optease filters to another location in the IVC after 21 days to prevent intimal growth over the filter struts in if removal is not yet indicated [13]. Nonetheless, the main advantage of Optease IVCF is its ease of handling which is particularly important in trauma patients and that is why these filters are commonly used. Considering the time limitations of Optease IVCF our center's current removal policy is to attempt removal or reposition within 3–4 weeks. However, as mentioned before, COVID-19 pandemic led to significant disturbances in medical care resulting in the increase of prolonged filter dwell time. In the present study, we found that Byrd sheaths might be successfully used as an advanced filter retrieval technique also after very long dwell time (over 8 months). This is valuable finding, because according to Desai et al. [14] the likelihood of retrieval failure

beyond 7 months is over 40% without advanced techniques. In addition to that, the rate of procedural complications is acceptably low and comparable with results described by other authors [9, 14, 15].

We are aware that our report has several limitations. The main limitations of our study are small sample size of enrolled patients which limits the validity of the data and its retrospective nature. Additionally, the absence of a control group treated with other methods might be perceived as a potential drawback.

In conclusion, this case series indicates that Byrd-assisted removal of embedded inferior vena cava filters is feasible and safe technique that could potentially improve the IVCF removal rate and should be therefore considered an interesting addition to the advanced techniques' spectrum.

Article information

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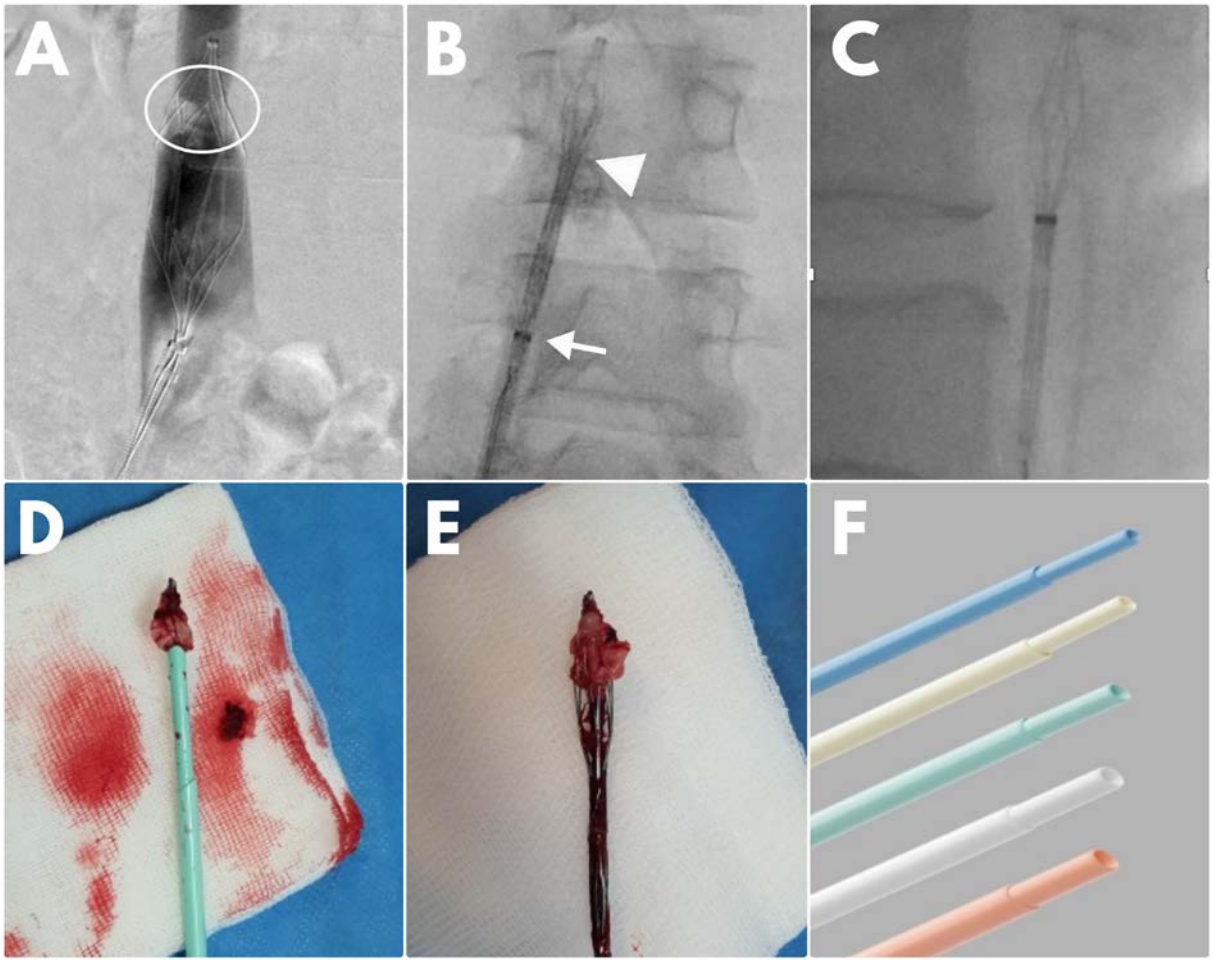

Figure 1. A 47-year-old female patient was admitted for IVCF retrieval 6 months after filter's implantation. Initial cavography showed filter's ingrowth into caval wall (**A**). After several attempts with traditional technique, Byrd dilatator (white triangle) was introduced via vascular sheath (white arrow) (**B**). Successful peeling of the adhesion tissue was performed and the filter was slipped into the sheath (**C**). Adhesion tissue and Byrd dilatator were removed (**D, E**). Available sizes of Byrd sheaths **(F**)