Tricuspid insufficiency after intracardiac migration of a Greenfield filter: Case report and review of the literature

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We report the only known case of intracardiac vena cava filter migration resulting in valvular dysfunction. Echocardiographic evaluation documented the filter stenting open the tricuspid valve, with wide-open regurgitation. This case, as well as 22 cases of filter migration reported in the English literature, are used as a background to review prevention and treatment strategies. (J Vasc Surg 1996;24:494-8.)

Since its introduction in 1972, the Greenfield filter has been widely accepted as effective therapy for the prevention of pulmonary emboli. Complications of placement include erosion of the inferior vena cava (IVC), filter migration, and symptomatic IVC obstruction. Although rare, migration to the right side of the heart and beyond has been reported. Tricuspid insufficiency after migration, however, has not been reported.[1-19] We report a case of Greenfield filter migration in which the filter lodged within the tricuspid valve and caused valvular dysfunction and arrhythmia. A review of the literature and current management strategies are also discussed.

CASE REPORT

A 78-year-old man with a past history of insulin-dependent diabetes, chronic renal insufficiency, and congestive heart failure underwent an elective right hemicolectomy for a large tubulovillous adenoma. The patient's postoperative course was complicated by a prolonged ileus and right common femoral vein thrombosis. Anticoagulation with heparin was begun but was discontinued 48 hours later because of upper gastrointestinal bleeding. The patient was then taken to the operating room for vena caval interruption.

A titanium Greenfield filter was inserted through the right internal jugular vein. An open technique was used to achieve suture closure of the venotomy because the operating surgeon was concerned about the possibility of hemorrhage from the insertion site. Under fluoroscopic guidance, the filter was placed at the L-1/L-2 level but lodged within the cava at a 45 degree angle. A second Greenfield filter was placed just above the first, again under fluoroscopic guidance. Immediately after placement it flipped over, so that the apex of the filter was caudad and the hooks cephalad. At this point the procedure was terminated. At no point during the procedure was vena caval diameter

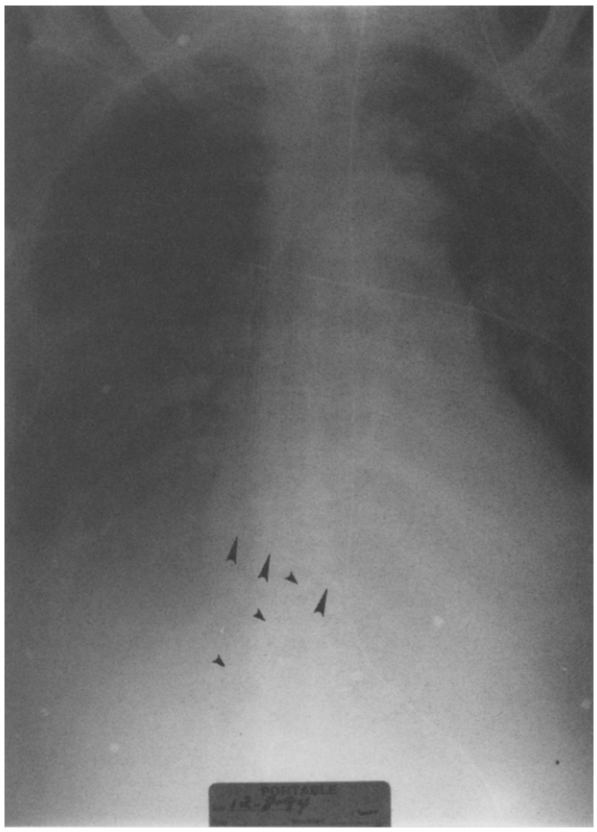

Fig. 1. Chest x-ray film immediately after filter placement. *Small arrows* outline first filter location. *Large arrows* outline second filter location near tricuspid valve.

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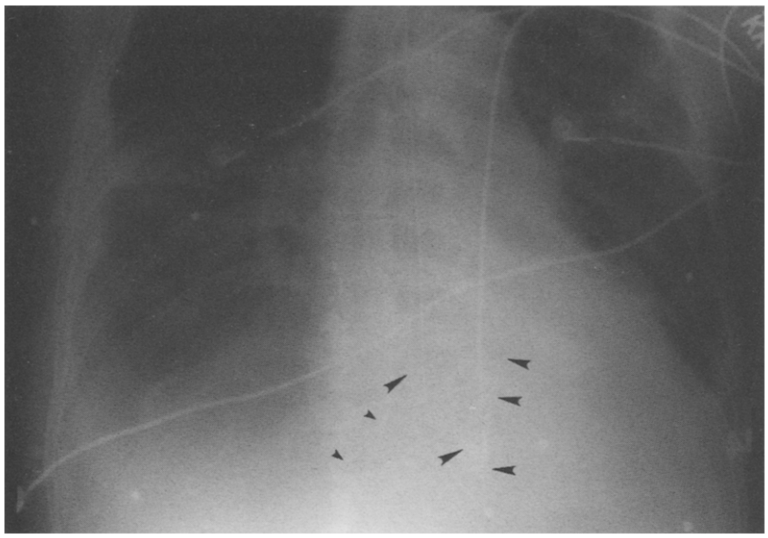

Fig. 2. Chest x-ray film after migration. *Large arrows* show filter prongs spread open in tricuspid valve area. *Small arrows* show that first filter has not moved.

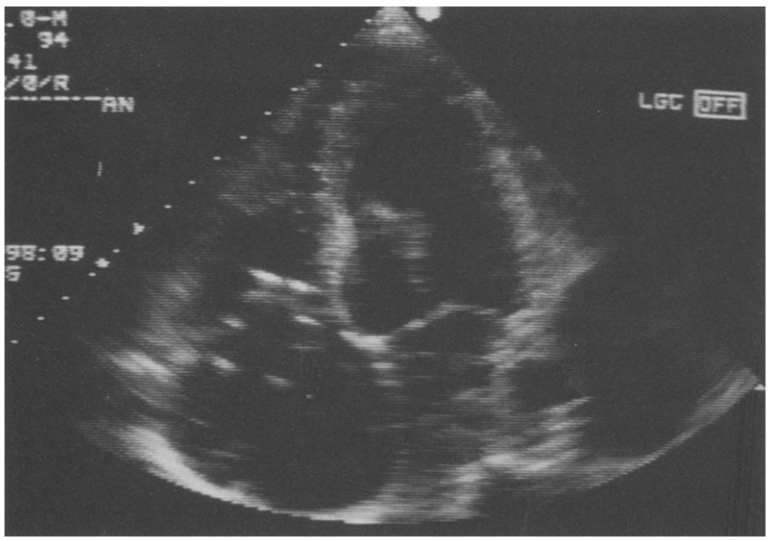

Fig. 3. Echocardiographic scan clearly shows filter prongs across tricuspid valve.

formally assessed. A chest roentgenogram showed the two filters, one at the T-11/T-12 position and one adjacent to the right atrium (Fig. 1). The patient was given a regimen of oral Coumadin (DuPont Pharma, Wilmington, Del.) and did well until 6 days later, when he developed respiratory distress (believed to be caused by congestive heart failure) that required endotracheal intubation and mechanical ventilation. An electrocardiogram at that time revealed sinus rhythm with frequent premature atrial and ventricular contractions. A chest x-ray film demonstrated that the superior filter had migrated into the heart and was resting in close proximity to the tricuspid valve (Fig. 2). An echocardiogram showed the filter lodged across the tricuspid valve (Fig. 3). Color Doppler revealed regurgitation of blood flow through the tricuspid valve during systole (Fig. 4).

Percutaneous retrieval of the filter was not attempted because the filter hooks appeared to be intertwined with the chordae tendonae, and the risk of valve damage was believed to be too great. A cardiothoracic surgeon was consulted. The patient and family, however, refused any further operative intervention. The patient's exacerbation of congestive heart failure improved with medical management, but results of cardiac monitoring continued to show frequent ectopy. On the sixteenth day after the filter placement procedure, the patient was found unresponsive with pulseless electrical activity. Attempts at resuscitation were unsuccessful. No autopsy was performed.

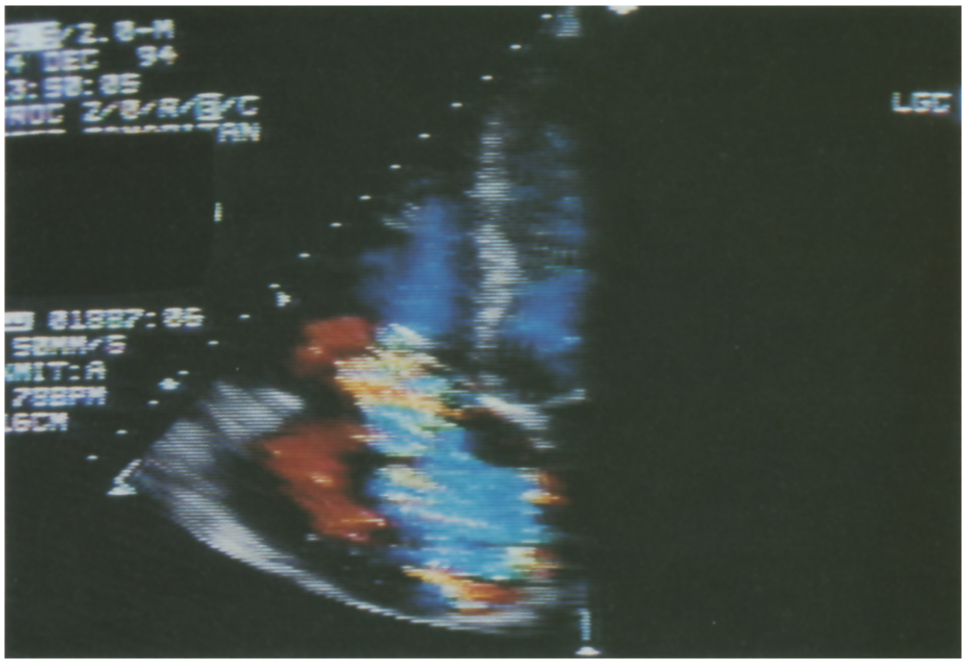

Fig. 4. Addition of color flow demonstrates tricuspid regurgitation.

DISCUSSION

The successful placement of a vena caval filter is dependant on several factors, one of which is an accurate assessment of the infrarenal cava. The various commercially available filter models have different maximal vena caval diameter requirements above which insertion is not recommended. For the titanium Greenfield filter used in this patient, the maximum allowable vena cava diameter is 28 mm. In this case, lack of accurate fluoroscopic assessment of the caval diameter was likely a major factor in the migration of the filter. The authors did not perform this insertion; it is our routine to measure caval diameter before insertion of a filter. A practical method is to place a radiopaque ruler behind the patient longitudinally. A cavogram through the insertion sheath is then performed fluoroscopically and the diameter of the cava measured against the centimeter marks of the ruler. This method allows for field magnification by fluoroscopy without distorting measurement proportions. The majority of previous reports of filter migration identify a technical mishap at the time of the initial insertion as the main cause of migration.

Although malposition and migration of Greenfield filters are not uncommon, our literature review yielded only 22 cases of migration to the heart or beyond (Table I). Although nearly half of these (10 of 22) have been asymptomatic, clinical manifestations of migration include arrhythmia and pericardial tamponade. Despite cases of filter leg entanglement in the proximity of the tricuspid valve, no previous cases of valvular incompetence have been documented. In our case, tricuspid insufficiency resulted from a direct stenting of the valve leaflets by the legs of the filter. Echocardiographic examination confirmed the anatomic location of the filter and the tricuspid insufficiency.

Significant arrhythmia has been reported in four previous cases, one of which resulted in cardiopulmonary collapse.[2,7,11,18] In the current case, significant atrial arrhythmias occurred after filter placement but resolved spontaneously. Although documented in only one previous case, pericardial tamponade is a catastrophic consequence of filter migration.[14] Our patient had electromechanical dissociation, so penetration of the myocardium by the filter legs with resultant pericardial tamponade is a possible explanation. Unfortunately, an autopsy was not performed.

If migration is suspected clinically or if a filter that was placed in the infrarenal vena cava is not visible on plain abdominal x-ray films, then a chest x-ray procedure is warranted. This procedure will provide information as to the approximate location of the filter. If the filter is clearly extracardiac, then no further diagnostic evaluation is necessary. If the filter appears to be intracardiac, then echocardiographic evaluation is indicated. Although the transthoracic route may yield adequate information, optimal visualization is

Table I. Migration of Greenfield filters

Author/year	*Location*	*Symptoms*	*Treatment*	*Outcome*
Greenfield, 1977[1]	RA	Unknown	Open removal	Unknown
Akins, 1980[2]	RA	Unknown*	Open removal	Survived operation; no follow-up
Castaneda, 1983[3]	RA; tricuspid	None	None	18 months; no problem
Moore, 1983[4]	RA	None	Open removal	Survived operation; no follow-up
Scurr, 1983[5]	Myocardial wall	Unknown*	None	Death
Friedell, 1986[6]	LPA	None	None	9 month follow-up; no problems
Hirsch, 1987[7]	RV	Premature ventricular contractions	Open removal	Survived operation; no follow-up
Hirsch, 1987[7]	RA	Brief ventricular tachycardia	Open removal	Survived operation; no follow-up
Tsai, 1988[8]	RA	Unknown*	Percutaneous removal	Unknown
Yakes, 1988[9]	RA	Unknown*	Percutaneous removal	12 months; no problem
Deutsch, 1988[10]	RA	Chest pain	Percutaneous removal	2 month follow-up; no problems
Bach, 1990[11]	RA	Multiple arrhythmias	Antiarrhythmics and implanted pacemaker	16 month follow-up; no problems
Puram, 1990[12]	RA	None	None initially, open removal 6 months after insertion	Coronary dissection with MI at 6 months after surgery
Gelbfish, 1991[13]	RPA	None	Failed percutaneous removal; observation	60 months; no problems
Gelbfish, 1991[13]	RPA	None	Coumadin; observation	42 months; no problems
Gelbfish, 1991[13]	RA	None	None	Died at 2 months; not filter-related
Lahey, 1991[14]	RA	Pericardial tamponade	Open removal	Survived operation; no follow-up
Sadighi, 1992[15]	RA; tricuspid	Unknown*	Percutaneous removal	1-year follow-up; no problems
Dorsa, 1992[16]	RA; tricuspid	None	Open removal	Survived operation; no follow-up
Rodriguez, 1993[17]	Atrium	None	Failed percutaneous removal; observation	7-year follow-up; no problems
Dorsey, 1993[18]	RA; tricuspid	Paroxysmal ventricular tachycardia	Open removal	Survived operation; no follow-up
Rao, 1993[19]	RPA	None	Open removal	Survived operation; no follow-up

*Removal performed same time as insertion. *RA,* Right atrium; *RV,* right ventricle; *RPA,* right pulmonary artery; *LPA,* left pulmonary artery.

through the transesophageal route. This not only provides detailed anatomic information, but will aid in determining whether percutaneous removal is feasible. In our case, a transthoracic echocardiogram provided both anatomic and functional information, with the filter legs clearly visible in the tricuspid annulus and wide-open regurgitation shown by color-flow duplex scan (Figs. 3 and 4).

Management of intracardiac filter migration is based on several factors, including the degree of cardiac dysfunction that results from the migration, the ease of percutaneous removal, and the patient's ability to withstand open removal through a sternotomy. Although success with percutaneous removal has been reported,[5,8,9,10,20] techniques are not standardized and results are operator-dependant. Greenfield and Crute[20] first reported a successful percutaneous retrieval system in dogs in 1980. Success in human beings followed, when Patterson et al.,[21] by withdrawing the filter into the carrier with a special flexible guidewire, successfully repositioned two filters that were partially discharged into the right atrium. Sadighi and Frost[15] achieved similar success with a double-wire snare technique. Considerable skill is required, but percutaneous removal represents the least stressful intervention for the patient. In addition, filter leg entanglement in the chordae tendonae of the tricuspid valve and migration into the pulmonary artery may make percutaneous removal impossible. In the current case, transthoracic echocardiographic evaluation clearly showed the filter legs in close contact with the tricuspid valve leaflets, and thus

percutaneous removal was not considered. Sternotomy and cardiopulmonary bypass with direct transatrial removal is the definitive means of filter removal. In this case, sternotomy was considered, but the patient and family refused all further operative intervention.

Not all patients will be stable enough to tolerate a sternotomy. In addition, that many reported cases have been asymptomatic has led some investigators to suggest observation as adequate treatment. Gelbfish and Ascer[13] reported three cases in which attempts at percutaneous removal from the right atrium failed, and observation alone was not associated with any filter-related complications. Rodriguez and Saltiel[17] reported no adverse sequelae in a 7-year follow-up of one patient whose filter migrated to the tricuspid valve. To date, no case of thrombosis proximal to the filter has been reported. In our case, some atrial arrhythmias occurred after filter placement, but it is unclear whether these arrhythmias or the patient's ultimate death were attributable to the presence of the filter.

In summary, we report the only known case of intracardiac vena cava filter migration resulting in valvular dysfunction. Echocardiographic evaluation documented the filter stenting open the tricuspid valve, with wide-open regurgitation. Because percutaneous removal was not feasible and operative removal was refused by the patient, death resulted on the sixteenth day after surgery. Presence of the intracardiac filter may have contributed to this patient's death.

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