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ORIGINAL ARTICLE

Intravascular Foreign Bodies Retrieval: Navigating Differences From Childhood to Adulthood

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Abstract

Background/Aim: The increasing number of cardiovascular procedures is coupled with higher cardiovascular foreign bodies (FB) embolisation into the circulation. Aim of this study was to analyse centre's experience with percutaneous retrieval of FB, emphasising the differences between paediatrics and adults and highlighting failure-related parametres.

Methods: A retrospective analysis of patients who underwent percutaneous retrieval FB in the heart and major blood vessels from February 2013 to April 2024 in the catheterisation lab at a specialised cardiovascular centre was performed. Data were subdivided into two groups: paediatric and adult. A collection was made of patient demographic and FB details, including type, site, the reason for introduction, duration of impaction, details of retrieval procedure including access site, types of catheters, device and sheath used, the time needed for extraction and whether the retrieval was successful.

Results: Twenty-two patients were included, 15 (68.2 %) adults and 7 (31.8 %) paediatric patients. The most common FB retrieved was a guide wire 7 (33 %) followed by an atrial septal occluder 6 (29 %). The right femoral artery was commonly accessed in both subgroups. Snare techniques were used in all patients. There were no complications or deaths reported. Overall procedure success was 18 cases (81.8 %), while the procedure failed in 4 (18.2 %) cases and those patients were referred to open surgery. No statistically significant differences were found between the patient's age, gender, the type of FB, the site of FB and the duration of FB impaction concerning the outcome of the procedure.

Conclusion: Percutaneous retrieval of cardiovascular FB is a safe, successful alternative to surgery. The success rate was comparable between adult and paediatric patients.

Key words: Cardiovascular; Foreign bodies; Paediatrics; Retrieval, snare.

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Introduction

Retrieval of cardiovascular foreign bodies (FB) represents one of the most delicate procedures performed by interventional cardiologists. Since endovascular procedures become ubiquitous, an increasing number of cardiac and vascular foreign bodies are being faced.[1] The exact incidence of endovascular FB is unknown, some reported an incidence of less than 1 % but underreporting is a great problem in this field.[1] Although the majority of FB are identified and retrieved acutely during the initial cardiovascular procedure, some reported a missed asymptomatic cardiovascular FB that remained for decades before attempting retrieval.[2]

Interventional equipment represents the most common FB in the heart and major blood vessels.[3] Over the years, reports of FB in the heart and major vessels focused on objects such as broken catheters, *vena cava* filters and guide wires. However, more recently, the spectrum of cardiovascular foreign objects has broadened to include items such as embolisation coils, endovascular stent components and septal occluders.[4] These different types of foreign bodies had different sites of impactions and subsequently mandated different access and techniques for retrieval.[5] Adding to this, different age groups require different approaches which increases the gap in our knowledge about the procedure.[5, 6]

The percutaneous retrieval of the FB was reported to cause multiple complications, including artery spasm, thrombosis and even perforation of the vessels. The retrieval of FB impact within the heart can result in serious complications like dysrhythmia or myocardial perforation.[7, 8] The success of percutaneous retrieval of cardiovascular FB in all published reports is high, ranging from 71 % to 100 %, which depends on the experience of the centre and the availability of facilities that are needed in such cases.[6] In addition to the site of impact of the foreign body, the size and the geometry of FB all prove to affect the outcome of foreign body retrieval.[8] Previously published reports discussed FB retrieval in either an adult or paediatric sample, but no previous report explored whether differences between the two groups exist.

Aim of this study was to analyse centre's experience with percutaneous retrieval of FB, emphasising the differences between paediatrics vs adults and highlighting failure-related parameters.

Methods

A retrospective study enrolled patients with embolised cardiovascular FB in a specialised cardiovascular centre in Baghdad, Iraq from February 2013 to April 2024 who underwent percutaneous retrieval for FB. During the referred period 22 cases were included; an exclusion was made for incomplete or missing data. The patient's medical history, procedure and related complications information from the centre database were reviewed for relevant information. For every included case, three sets of data were reviewed:

- *Demographic data*, including patient's age, gender and the medications received by the patients;
- *The FB-related data* included the FB type, site of impaction, duration of FB impaction, an indication that led to FB introduction to the patient;
- *Details of the retrieval procedure*, the type used to access the case, the devices and catheters used and whether the retrieval succeeded.

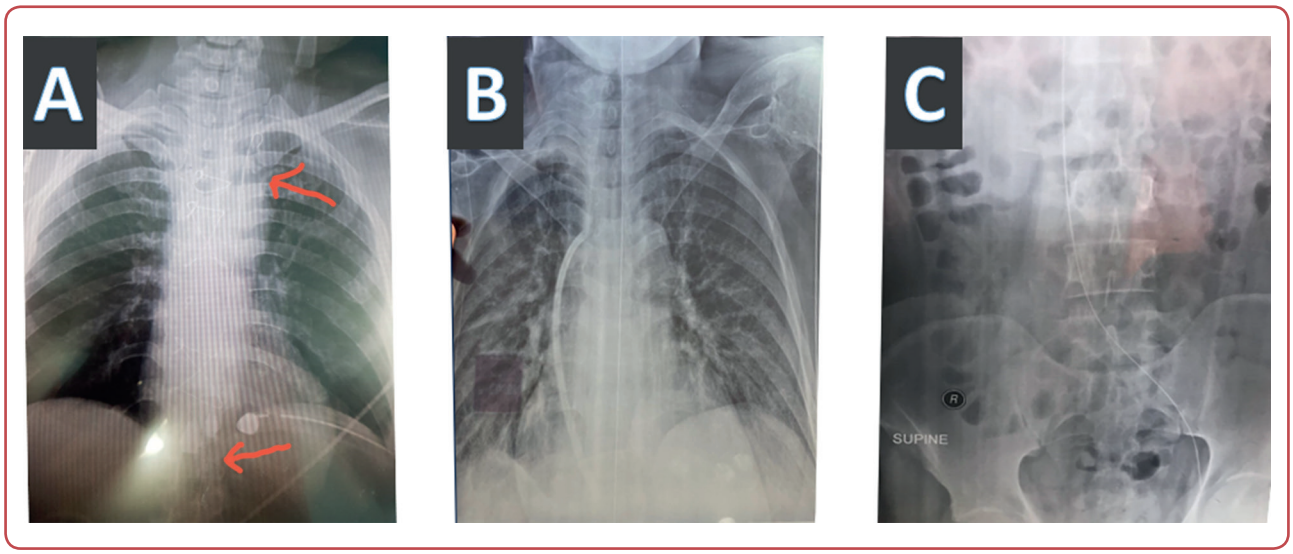

Figure 1: A) Chest X-ray (CXR) shows missed guide wire in descending aorta in patient underwent open heart surgery); B) CXR shows double lumen missed in right side of the heart; C) CXR shows missed guide wire in the inferior vena cava to femoral vein.

Procedure details

FBs were primarily approached via single femoral access, except for one patient, requiring a second contralateral femoral access as the common iliac vein was thrombosed on left side so access via right femoral vein was tried. The instrument used in all cases was gooseneck snares *Amplatzer*, USA (nickel-titanium cable), with a loop of 10 mm. It was introduced through vascular access over a 4 F guiding catheter, a multipurpose catheter 6 F used to snare the missed guide wire from its soft tip and for pieces of the embolised double lumen used in renal dialysis. A Judkins R (JR4) catheter and pigtail catheter were used to snare embolised occluders using a delivery sheath that was 2 F larger than the recommended one to deliver the occluder to make snaring easier.

The retrieval was considered "successful" when FB was completely retrieved or partial repositioning of the intravascular object where FB impacts the subcutaneous tissue. Here, the surgeon had to open the skin to retrieve the FB. "Failure" was considered when a patient was referred to open surgery. Patients were subdivided into two groups: paediatric cases (n = 7, age < 15 years old) and adult cases (n = 15, age > 15 years and above) (Figure 1).

Statistical analysis

Data of interest were transcribed and analysed. The categorical data were presented as numbers and percentages and analysed using Fisher's exact test. A student t-test was used for continuous data. The significance level was set at double sided p-value < 0.05.

Results

From February 2013 to June 2024, 22 cases (15 adult and 7 paediatric patients) were subjected to percutaneous FB retrieval. Fifteen (68.2 %) of the included cases underwent interventional procedures in catheterisation lab and were done by first cardiologist 1 (C1). Seven cases (31.8 %) were referred cases from other departments (renal, orthopaedics and vascular department) and were performed by the 2nd cardiologist (C2).

Patients' demographic and medication data

The age and gender distribution in paediatric group was age range of (1-13) years with median age of 7 years, including 4 male (57.1 %) cases. For the adult patients, the median age were 18 years with the age range (16-62) years including 5 male cases (33.3 %). All paediatric patients received heparin therapy (100 %) while only 9 adult cases (60 %) received heparin. All paediatric patients, except for one, were under antibiotic cover (85.7 %), compared to 8 cases (53.3 %) in the adult group.

FB data-related data

Regardless of the patient's age, the most frequent type of FB was guided wire which was seen in 7 cases (33 %), followed by occluders in 6 (29 %) cases, while the least reported FB were embolised stent and piece of balloon with each reported in 1 case (5 %) separately (Table 1 and 2). The most frequent site for FB to impact was the descending aorta in both the adults and paediatric groups, 7 (46.7 %) and 4 (57 %), respectively.

The reason behind the introduction of FB in paediatrics was atrial septal defect (ASD) closure in 4 (57.1 %) cases. As for adults, it was guiding wire 7 (46.7 %) either for central venous pressure line insertion or arterial line for patients who had major surgery. The FB retrieval was attempted immediately in all paediatric cases but one which was done in less than 24 h; as for adults the procedure done immediately in 4 cases (16.7 %) and less than 24 h for 5 (33.3 %) cases (Table 2). Of note is that the longest time for FB impaction was reported in one of the adult cases, which was 3 years as a result of patient's refusal to perform the procedure.

Details of the retrieval procedure

A gooseneck snare kit was used for all adult and paediatric patients (100 %). The catheter used in FB extraction was a multipurpose catheter MPC 6 F in all paediatric cases (100 %). In adults, the catheter used was MPC 6 F in 11 cases; however, an additional catheter was needed in 4 cases, a Judkins R (JR4) catheter in 2 cases and pigtail catheters in the other 2 cases.

The size of the sheath used ranged from 6-12 F in paediatric. As for adults it ranged from 6-14 F. Sheath 6 F was used in 10 cases (45.4 %) in the whole sample, divided into 2 paediatric cases (28.6 %) and 8 adults (53.3 %), as seen in Tables 1 and 2.

The retrieval was successful in 18 cases, with an overall success rate of (81.8 %). Success was reported in 5 (71.4 %) paediatric cases in comparison to 13 (86.7 %) cases among adults. The procedure failed in 4 cases: 2 paediatric cases (28.6 %) and 2 adults

Table 1: Characteristics of retrieval procedures in children

N	Age year	Sex	Heparin use	AB use	FB type	Impaction site	The reason behind FB introduction	Time of FB stay	Catheter used	Devise used	Sheath, F	Retrieval success
1	1	F	Yes	No	Piece of balloon	DA	Balloon angioplasty for severe COA	Immediately	MPC 6 F	Snare	6	Yes
2	3	M	Yes	Yes	Piece of DL	RV - PA	Dialysis for CKD	< 1 day	MPC 6 F	Snare	6	Yes
3	7	F	Yes	Yes	ASD occluder size 16mm	RA	ASD secundum closure	Immediately	MPC 6 F	Snare	12	No
4	7	F	Yes	Yes	ASD occluder size 16mm	RA	ASD secundum closure	Immediately	MPC 6 F	Snare	10	No
5	9	M	Yes	Yes	ADO1 size 8-6mm	DA	Sub-aortic VSD closure	Immediately	MPC 6 F	Snare	8	Yes
6	12	M	Yes	Yes	ASD occluder size 14mm	DA	ASD secundum closure	Immediately	MPC 6 F	Snare	10	Yes
7	13	M	Yes	Yes	ASD occluder size 16	DA	ASD secundum closure	Immediately	MPC 6 F	Snare	10	Yes

ASD: atrial septal defect; AB: antibiotics; ADO1: Amplatser septal occluder no 1; DA: descending aorta; COA: coarctation of aorta; D: double lumen, FB: foreign body, F: female MPC: multipurpose catheter, M: male, PA: pulmonary artery; RA: right atrium, RV: right ventricle; CKD chronic kidney disease; N: case number;

Table 2: Characteristics of retrieval procedures in adults

N	Age year	Sex	Heparin use	AB use	FB type	Impaction site	The reason behind FB introduction	Time of FB stay	Catheter used	Devise used	Sheath, F	Retrieval success
1	16	F	Yes	Yes	ASD occluder size 14mm	DA	ASD secundum closure	Immediately	MPC 6 F	Snare	12	Yes
2	16	F	No	No	DL	SVC, RA, RV	Dialysis for CKD	7 days	MPC 6 F	Snare	10	Yes
3	16	M	Yes	Yes	ADO1 size 8-6mm	DA	VSD closure	Immediately	MPC 6 F	Snare	8	Yes
4	17	M	No	No	DL	Left pulmonary artery	Osteogenic sarcoma with right leg imputation	17 days	MPC 6 F	Snare	6	Yes
5	17	F	Yes	Yes	Guide wire 0.035 length 50 cm	IVC-RA	CVP insertion for open heart surgery	6 h	MPC 6 F	Snare	6	Yes
6	17	M	Yes	Yes	ASD occluder size 36mm	PA	ASD secundum closure	Immediately	pigtail, MPC 6 F	Snare	14	No
7	17	F	Yes	Yes	Guide wire 0.035 length 50cm	DA	Arterial line insertion to monitor arterial pressure	6 h	MPC 6 F	Snare	6	Yes
8	18	F	Yes	Yes	ADO1 size 10-8mm	DA	VSD closure	Immediately	MPC 6 F	Snare	12	Partially
9	19	M	No	No	Guide wire 0.035 length 50 cm	RV, RA, IVC	CVP line insertion for bullet injury victim	14 days	MPC 6 F and pigtail	Snare	6	Yes
10	21	M	No	No	Guide wire 0.035 length 50 cm	SVC, RA, IVC	CVP line insertion for explosion victim	45 days	MPC 6F, JR4 catheter	Snare	6	Yes
11	23	F	Yes	No	RRA stent	RRA-DA	RRA stenosis	3 h	MPC 6 F	Snare	10	Yes
12	34	F	Yes	No	Guide wire 0.035 length 50 cm	REJV- RFV	DL insertion for CS site in VWD case	3 years	MPC 6 F	Snare	6	No
13	35	F	Yes	No	Guide wire 0.035 length 50 cm	DA – LCCA	Arterial line insertion to APM for open heart surgery	6 h	MPC 6 F	Snare	6	Yes

14	57	F	Yes	No	DL	SVC-RA	Patient has dialysis	13 days	MPC 6 F	Snare	10	Yes
15	63	F	Yes	Yes	Guide wire 0.035 length 50 cm	DA-LCCA	APM patient has CABG	7 h	MPC 6 F, JR4 catheter	Snare	6	Yes

APM: arterial pressure monitoring; ADO1: Amplatser septal occluder no 1; C/S: caesarean section; CABG: coronary artery bypass grafting; ASD: atrial septal defect; VSD: ventricular septal defect; DA: descending aorta; DL: double lumen; FB: foreign body; F: female; IVC: inferior vena cava; SVC: superior vena cava; JR4: Judkins R; LCCA: left common carotid artery; MPC: multipurpose catheter; M: male; PA: pulmonary artery; RA: right atrium; RV: right ventricle; RFV: right femoral vein; RRA: right renal artery; REJV: right-external jugular vein; VWD: von Willebrand disease; CVP line: central venous catheter; N: case number;

Table 3: Distribution of study parameters linked with failure and success rates

Variables	Failed (N = 4)	Success (N = 18)	P-value
Age (mean ± SD)			
Paediatrics	7.0 ± 0.0	7.6 ± 5.4	0.565†
Adults	25.5 ± 21.0	25.4 ± 21.0	
Gender			
Male	1 (25.0 %)	8 (44.4 %)	0.616*
Female	3 (75.0 %)	10(55.6 %)	
Types of foreign body			
ASD occluder	3 (75.0 %)	3 (16.6 %)	0.499*
Guidewire	1 (25.0 %)	6 (33.3 %)	
ADO1 size	0 (0.0 %)	3 (16.6 %)	
DL	0 (0.0 %)	4 (22.2 %)	
RRA stent	0 (0.0 %)	1 (5.6 %)	
Piece of balloon	0 (0.0 %)	1 (5.6 %)	
Site of impaction			
DA	0 (0.0 %)	9 (50.0 %)	0.127*
RA	3 (75.0 %)	5 (27.8 %)	
Other sites	1 (25.0 %)	4 (22.2 %)	
Operating cardiologist			
Cardiologist 1	4 (100.0 %)	11 (61.1 %)	0.535
Cardiologist 2	0 (0.0 %)	7 (38.9 %)	
Time for FB retrieval			
Immediately	3 (75.0 %)	8 (44.4 %)	0.286*
Within 24 h	0 (0.0 %)	5 (27.8 %)	
1 day-1 week	0 (0.0 %)	1 (5.6 %)	
1 week-2 weeks	0 (0.0 %)	2 (11.2 %)	
2 weeks-2 years	0 (0.0 %)	2 (11.2 %)	
> 2 years	1 (25.0 %)	0 (0.0 %)	

*PA: pulmonary artery; RA: right atrium; RV: right ventricle; DA: descending aorta; DL: double lumen; FB: foreign body; F: female; IVC: inferior vena cava; † Student t-test, *Fisher exact test. ASD: atrial septal defect; ADO1: Amplatser septal occluder No 1; DL: double lumen; RRA: right renal artery;*

(13.3 %) and eventually referred to open surgery. In one case, the foreign body was impacted by subcutaneous tissue and the surgeon had to open the skin to retrieve the FB. No major complications or death was reported among all managed cases during period of hospitalisation and on follow up for one year following the time of procedure.

All the studied variables including patient's age, gender, the type of FB, the site of FB and the duration of FB impaction did not exert a statistically significance difference in relation to the outcome of the procedure (Table 3).

Discussion

The current study showed that the FB retrieval success rate in a single Iraqi cardiac centre was (81.8 %), with higher success rates among adults. The most frequently encountered FB was guided wire and ASD occluder and the most frequent impaction site was the descending aorta. The femoral vein and artery were the most common access sites. Most FB retrieval was performed immediately in paediatric patients compared to only (16.7 %) of the adult cases retrieved immediately. The success rate was comparable between adult and paediatric patients. There is a debate about the gold standard method of cardiovascular FB removal, especially in low-resource countries.[9] Cardiovascular FBs are diverse, with interventional equipment being the most common type reported nowadays.[9-11]

In this series, the most common FB retrieval was guidewires seen in 9 (33 %) cases; this matches Nguyen et al.[12] A fractured port catheter was retrieved in the majority of patients in Koseoglu et al[4] and Salimi et al[3] and Carroll et al[8] studies. In previous reports among paediatric patients, catheter fragments were the most retrieved FB,[13] which contradicts this study's results, where ASD occluder was most frequent, seen in 4 (57.0 %) cases.

The current series showed that the most frequent site for FB to get impacted is the DA in 7 (46.6 %) among adults, while other studies had RA as the most frequent as Lyu et al and Bonvini et al studies.[14, 15] In paediatric patients, the DA was the most frequent site for impaction at 4 (57.0 %) of the cases, in line with the Pazinato paediatrics case series, which analysed 14 cases.[5] This dif-

ference may be attributed to varying types of FB reported in those studies, specifically port catheters.

In most of the operated cases, one access for FB retrieval was used, which matched previous studies.[3, 16] The main access used was the right femoral artery and vein, regardless of the patient's age, which aligns with other reports.[6, 9, 17] It is worth mentioning that jugular vein access, as reported by Salimi et al was used for FBs that impacted the atrium and inferior vein. They discussed that this access could decrease the procedure duration and subsequently, the radiation exposure will be minimised.[3]

All paediatric cases underwent surgery within less than 24 h following FB embolisation compared to the Pazinato paediatric case series, which had a 215-day mean value to diagnose FB.[5] Bonvini's study included 22 adult cases; FB time of diagnosis ranged from 2 weeks to 7 years. In presented series, the longest diagnosis time was three years, as the patient refused the procedure against medical advice. This is not surprising given that the longest time reported for an FB in the heart exceeded 20 years.[15]

Over the years, various types of intravascular FBs demanded the use of different devices for retrievals, like snares, forceps, baskets, tip-deflecting wires, pincher devices, overheats and balloon catheters.[18] However, the gooseneck snare was the most common device used due to its high success and low complication rate.[3] This matches the current results, where it was used in 100 % of the patients with no major complications, regardless of their age and type of FBs. All this makes the snare a favourable method of FB retrieval. The snare has evolved over the years as the earliest snare had a loop with an orientation that matched the axis of the introducing catheter, but more recently, the right-angle design of the gooseneck snare made the capturing of FB easier.[4]

In the current study, the success rate of percutaneous cardiovascular FB retrieval was 81.2 %, which is considered satisfactory compared to success rates in more developed, better-equipped countries, with reported success rates ranging from 79.2 % up to 100 %.[3, 4, 6, 12]

Failure of percutaneous retrieval in presented study was not significantly associated with FB type, site of impaction, patient age group and duration of the procedure, which is in accordance with earlier work.[19] Previous studies have identified factors associated with higher success rates in FB retrieval, including the type and size of the device utilised;[19, 20] however, since all patients were managed with the snare technique the influence of this point in presented results was not analysed.

Strengths and limitations of the study

The shortage of different types and sizes of devices used for extraction in our centre may affect the success rate as a 10 mm snare was the only device available, which is one of this study's limitations. A small number of included cases limits the ability to draw statistical significance, not to mention that a single-centre study may limit the globalisation of study results.

It's the first long study among Iraqi patients that compared paediatric and adult patients with comprehensive data analysis, including case demographics, FB data and procedure-related information. Many of the earlier reports discussed either adults or paediatrics and were hindered by the heterogenicity of the used devices, which was not the case here. All cases were operated by snare so the results can be standardised. The parameters linked with higher failure rates were highlighted, which will be of value in pre-surgical counselling and in adopting a personalised patient approach to improve success rates. The current results may open the path for multicentric large-scale study in other cardiac interventional centres in Iraq in the future.

Conclusion

The percutaneous retrieval of cardiovascular foreign bodies is an alternative procedure to surgery as it has a high success rate and is almost devoid of complications. The success rate was comparable between adult and paediatric patients.

Ethics

The Ethics Committee of Baghdad University issued the study approval with a number (IRB 50), dated 28 May 2024.

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None.

Conflicts of interest

The authors declare that there is no conflict of interest.

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Data access

The data that support the findings of this study are available from the corresponding author upon reasonable individual request.

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