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Management of Retained Intervention Guide-wire: A Literature Review

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Abstract: Percutaneous coronary angioplasty is increasingly employed in the treatment of patients with complex coronary artery disease.

Different steerable guide wires used to open occluded vessel and facilitate balloon and stent deployment. However, the guide-wire itself is not without hazard: it may perforate or dissect the vessel, but fracture or entrapment is uncommon. Its management depends on the clinical situation of the patient, as well as the position and length of the remnant.

In this review we discuss the angioplasty guide-wire fracture and entrapment risk factors, potential risks and management.

Keywords: Coronary Angioplasty, Guide-wire Fracture, Guide wire Entrapment, Retained guide wire remnant, Guide wire Retrieval.

INTRODUCTION

Entrapment and fracture of coronary guide-wire is a rare complication of percutaneous coronary interventions (PCI). The incidence of these complications is approximately 0.1- 0.2 % [1, 2]. Entrapment or over-rotation of the distal tip of the angioplasty guide wire can lead to the wire rupture [3]. Excessive bending produces a high tensile load to the guide-wire, especially when applied to the junction point between the very flexible distal 3-cm tip and the remainder of the guide wire, may result in wire fracture [4]. Retention of hardware components in the coronary tree has been recently reported to complicate coronary angioplasty [1, 5].

The management of patients with retained catheter or wire fragments within the coronary artery tree is difficult. Small fractured components can be left within a chronically occluded coronary artery without sequelae [1, 6, 7]. Since intravascular wire fragments are highly thrombogenic, immediate surgical removal, eventually combined with bypass grafting may be indicated if percutaneous retrieval is unsuccessful or difficult [8].

Here, we review the literature for published data in English about entrapped angioplasty wire and summarize the management options available.

METHODS

We searched the Medline (PubMed), Embase, EBSCO, ScienceDirect and Cochrane databases for published data or reports in English from 1980 to 2012 using the Medical Subject Heading terms "coronary guide-wire fracture, entrapment, unraveling, or retained guide-wire fragments."

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RESULTS

A literature search revealed a total of 67 patients in 48 reports with guide-wire entrapment and different management approaches which involved percutaneous and surgical retrieval of entrapped fragments and conservative therapy for some cases Table **1**.

The wire entrapment was reported in the right coronary artery (RCA) in 22 cases, left anterior descending artery (LAD) in 25 cases, left circumflex artery (LCX) in 19 cases and ramus intermedius artery (RI) in 2 cases.

The surgical extraction was performed in 29 cases (43.3%) and percutaneous therapy used in 28 cases (41.8%), while 10 cases (14.9%) received conservative therapy [1, 3, 9-14] Fig. (**1**). Interestingly, floppy wires were used in most of the cases.

Several percutaneous techniques used for retrieval of entrapped guide-wire fragments including stenting against the vessel wall (7 cases) [12, 15-19], snare loop (9 cases) [1, 20-25], double or triple wire technique (3 cases) [7, 26, 27], bioptome (1 case) [1], tornus micro-catheter (1 case) [28], deep-guide catheter wedging with balloon inflation (6 cases) [1, 3, 29, 30] and pigtail catheter (1 case) [6].

DISCUSSION

Prevalence of Coronary Guide Wire Fracture

Hartzler and colleagues reported angioplasty guide-wire retention in 8 cases of 5,400 consecutive Percutaneous transluminal coronary angioplasty (PTCA) procedures, 4 patients with retained wire segment treated conservatively had no clinical sequel on long-term follow-up [1]. The broken or retained guide-wire is a rare complication of angioplasty procedures, with an estimated incidence of 0.1 - 0.2 % [1, 2].

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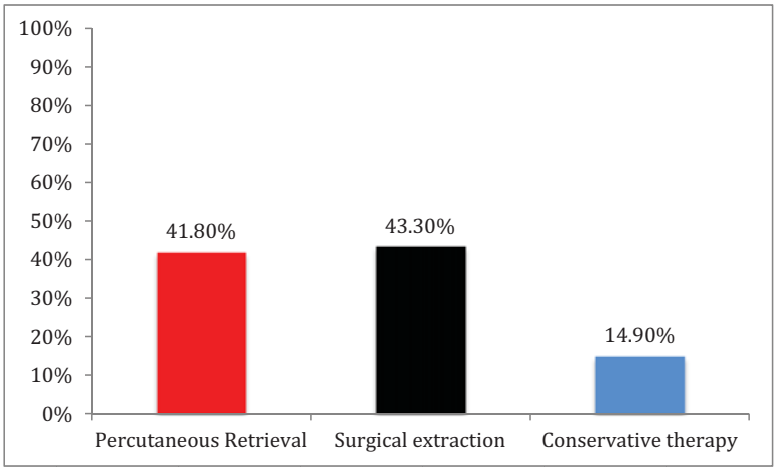

Fig. (1). Management approaches used for entrapped wire fragment.

Risk Factors for Guide Wire Fracture

The possible mechanics of the rupture of these delicate, soft wires entails several factors: the usual practice of PTCA is to advance the wire across the stenotic lesion for a distance to facilitate guidance of the balloon easily across the stenosis. The guide-wire is rotated during advancement to negotiate the correct course. This rotational maneuver should never exceed 180 degrees. Excessive rotation, especially if the tip is not free, leads to lateral stress caused by torqueing and unraveling of the platinum coil and precipitates rupture [31].

Risk of Retained Guide Wire Filament

The guide-wire remnants can lead to complications, such as perforation, thrombosis, embolic phenomena and vessel occlusion [5, 8, 31].

Rationale of Guide Wire Fragments Extraction

Since the guide-wire is thrombogenic and its presence inside the coronary or hanging up into the aorta may carry a risk of thrombo-embolization, this makes the fragment removal is essential to minimize this risk.

MANAGEMENT STRATEGIES OF RETAINED GUIDE WIRE REMNANTS

General Considerations of Retrieval

The percutaneous coronary intervention is usually completed uneventfully, with satisfactory results for the operator and the patient. Complications are unusual but when they do occur the sequences are serious. The operator should understand how to deal with them. One such complication is the guide-wire entrapment and the decision-making depends on whether the wire is still intact or fractured, and the site and extent of entrapment. The choice of guide catheter for more effective support is a crucial step and, given the prolonged nature of retrieval procedure, meticulous attention should be paid to ensure adequate anticoagulation.

In a case of guide-wire fracture, three therapeutic options are considered: percutaneous retrieval, surgical removal, or leaving the corpus alienum in-situ. The most elegant one is the non-surgical procedure by capturing the fragment depending on the operator`s comfort and experience. However, this approach carries the risk of additional vascular trauma, coronary spasms, or new fragmentation. If the removal by catheter fails and/or local myocardial ischemia arises with or without circulatory instability, and especially when extravasation of contrast medium gives evidence of vessel laceration urgent operation is indicated. Table **2** summarizes the possible methods of extraction of the retained guide-wire fragments.

Catheter Based Retrieval

There is no device designed for fractured wire retrieval. Retrieval can be attempted using a further two or more wires passed alongside the entrapped wire, and the torque is then applied to all wires and a twisting action results in wires wrapping around the retained wire and trapping it between the wrapped portions. The twisted group is then retracted, pulling out the entrapped wire out of coronary towards the guide catheter then externalization of the catheter and the wires as one unit [7, 26, 27].

A deep-guide catheter wedge and balloon inflation technique is another method by which the entrapped wire can be retrieved. This is a method used if the wire is still intact and the guide is over-wedged, then the balloon is advanced and inflated at the terminal part of the guide catheter and is tightly trapping the wire and the whole system is retracted to pull out the retained wire [1, 3, 29, 30]. Another method to free the retained wire is the use of tornus micro-catheter, in which the micro-catheter is advanced with particular rotations to the tip of the wire to allow for the release of the jailed or entrapped part [28].

The use of a snare loop to retrieve the entrapped guide-wire fragment was successful in some cases, but the snare may not match the vessel diameter. The gooseneck snare was the most commonly used technique and more suitable for proximal, large size vessels.

Table 1. List of the Published Reports in English About Guide Wire Entrapment

Date	Report	Number of Patients	Location of Fractured Wire	Extension of the Remnant Filament into Aorta	Management	Technique Used for Retrieval
1985	Steele *et al*.	1 patient	Acute marginal branch of RCA	Ascending aorta	Percutaneous retrieval	Snare loop technique
1986	Khonsari *et al*.	1 patient	LAD- subintimal	LAD	Surgical removal and CABG	Surgical extraction and CABG
1986	Keltai *et al*.	1 patient	LAD	Ascending aorta	Surgical removal	Surgical extraction and CABG
1986	Krone *et al*.	1 patient	LAD	Descending thoracic aorta	Percutaneous retrieval	Pigtail catheter
1987	Lotan *et al*.	4 patients	LCX LAD LAD OM	-Intact - Intact -Ascending aorta - LCX	Percutaneous retrieval in 2 patients. Surgical in 1 case. Conservative in 1 case	Balloon and deep wedging in 2 cases and Surgical extraction in 1 case and conservative in one case
1987	Hartzler *et al*.	8 patients	4 cases RCA 3 cases LCX 1 case LAD	-1case abdominal aorta	- Successful wire extraction 3 cases and failed in one case. - Wire retrieval in one case and conservative in other 2 cases. - Conservative	- Snare loop technique in 3 cases and bioptome technique in one case. - Balloon inflation technique in one case and no attempts in other cases. - No extraction attempt.
1987	Watson	2 patients	Diagonal branch LCX	Ascending aorta. Intact wire inside guiding	Percutaneous retrieval and PTCA. Retrieval with snare and CABG	Snaring technique for both cases
1987	Arce-Gonzalez JM	3 patients	-2 patients in whom guide wire entrapped in LCX - 1 patient wire entrapped in distal PDA branch of RCA	- Intact wire in first 2 patients - Fractured wire extend to descending aorta through SVG to PDA	- Percutaneous removal in 2 case -Surgical extraction in 1 case	- Deep wedging of guide catheter and balloon then traction of the system as a unit in both case. Surgical extraction and SVG to PDA
1987	Stellin	1 patient	LAD	Aortic arch	Surgical removal	Surgical extraction
1988	Steffenino *et al*.	1 patient	NA	NA	Surgical removal	Surgical extraction
1988	Mikolich *et al*.	1 patient	Diagonal branch	Proximal LAD	Percutaneous retrieval with snare loop	Snaring technique
1988	Proctor *et al*.	1 patient	Distal LCX	Ascending aorta	Surgical removal	Surgical extraction
1988	Vrolix *et al*.	1 patient	Mid LCX	LM	Surgical extraction	LCX arteriotomy and CABG
1988	Bachenheimer *et al*.	1 patient	OM	LCX	Surgical removal	*OM Arteriotomy*
1989	Ghosh *et al*.	2 patients	Distal RCA in both	Ascending aorta	Surgical removal	Aortotomy in one case and coronary arteriotomy in the other one
1989	Seifert *et al*.	1 patient	RCA	RCA	Surgical	Surgical extraction
1989	Serota *et al*.	1 patient	RCA	SVG to RCA	Percutaneous retrieval	Snaring technique
1989	Sethi *et al*.	1 patient	LAD	LM	Surgical	Surgical extraction

(Table 1) contd…..

Date	Report	Number of Patients	Location of Fractured Wire	Extension of the Remnant Filament into Aorta	Management	Technique Used for Retrieval
1990	Doorey *et al*.	1 patient	Ramus intermedius artery	Ramus intermedius artery	Failed retrieval, medical with systemic anticoagulation then CABG	CABG with retained fragment not removed
1990	Doring *et al*.	1 patient	PDA	RCA	Conservative therapy	Conservative
1991	Maat *et al*.	1 patient	Ramus intermedius artery	Ascending aorta	Surgical removal	Surgical extraction
1991	Savas *et al*.	1 patient	Distal RCA	Proximal RCA	Percutaneous fractured wire retrieval	Two 0.014 guide wires are connected at the distal ends by a square knot
1998	Woodfield *et al*.	1 patient	RCA	RCA	Surgical Extraction and CABG	Surgical Extraction and CABG
2000	Patel *et al*.	1 patient	LCX	Guide Catheter	Percutaneous broken wire retrieval	Trapped inside guide Catheter with balloon inflation
2002	Chang *et al*.	1 patient	RCA	Aortic root	Surgical removal	Surgical extraction and CABG
2004	Chamuleau	1 patient	Distal RCA		Conservative therapy	Conservative
2004	Cafri *et al*.	1 patient	Diagonal branch	SVG to diagonal	Stenting against SVG wall	Stenting against SVG wall
2005	Khamberkar *et al*.	1 patient	Acute marginal branch of anomalous RCA from LSV	Mid RCA	Stenting of Mid RCA and wire remnant Jailed	Stenting of Mid RCA and wire remnant Jailed
2005	Ozkan *et al*.	1 patient	RCA	RCA	Conservative therapy	Medical
2006	Alexiou *et al*.	3 patients	LAD in 2 cases and RCA in 1 patient		Surgical removal	Surgical extraction
2006	Van Gaal *et al*.	1 patient	Mid LAD	Ascending Aorta	Stenting against vessel wall after failed retrieval	Stenting and medical therapy
2006	Kim *et al*.	1 patient	RCA	Intact wire	Surgical removal and CABG	Aortotomy and coronary arteriotomy and removal of wire and stent
2007	Cho *et al*.	1 patient	LCX	Intact wire	Percutaneous retrieval	Tornus Catheter
2007	Collins *et al*.	1 patient	LAD	LM	Percutaneous retrieval	Triple entangling technique
2007	Darwazah *et al*.	2 patients	LCX Diagonal branch	LM Proximal LAD	Surgical removal for both cases and CABG	Surgical removal and CABG
2008	Capuano	1 patient	Diagonal branch	Intact wire	Partial Surgical extraction and CABG	Aortotomy with partial extraction and CABG
2008	Kilic *et al*.	1 patient	Side branch of LCX	Proximal LCX	Wire fixed against vessel wall with Stent	Fixed with stenting
2008	Demircan *et al*.	1 patient	LCX	Proximal LM and guide catheter	Percutaneous retrieval	Double wire single torque twisting
2009	Chu *et al*.	1 patient	PDA	PDA	Fixed with stent to side wall	Fixed with stenting
2009	Gagnor *et al*.	1 patient	OM	LCX and LM	Percutaneous removal of stent and fractured guide wire	Snaring with Amplatz gooseneck snare

(Table 1) contd…..

Date	Report	Number of Patients	Location of Fractured Wire	Extension of the Remnant Filament into Aorta	Management	Technique Used for Retrieval
2009	Micovic *et al*.	1 patient	Septal branch	Proximal LAD	Surgical	Aortotomy and coronary arteriotomy
2010	Burns *et al*.	1 patient	Diagonal branch	LM	Percutaneous retrieval	Goose-neck snare
2010	Balbi *et al*.	1 patient	Diagonal branch	Aortic root	Surgical removal and Diagonal grafting	Two stage removal distally from diagonal and proximally via aortotomy
2010	Karabulut *et al*.	3 patients	-Distal LCX -Distal PDA (RCA) -Mid LCX	- Mid LCX -Distal RCA -Mid LCX	-Stenting against vessel wall - Conservative Therapy -Stenting	-Fixation with Stent -Failed retrieval -Fixation with a stent
2010	Hong *et al*.	One patient	Distal LAD	Ascending Aorta and Arch	Conservative therapy	Failed retrieval
2010	Kaplan *et al*.	One patient	Distal RCA	None	Conservative therapy	Failed retrieval
2011	Modi *et al*.	One patient	Proximal LAD	Ascending Aorta	Surgical removal and CABG	Removal via Aortotomy
2012	Al-Amri *et al*.	One patient	Proximal LAD	Ascending Aorta	Surgical removal and CABG	Left main arteriotomy and patch

Table 2. **Methods of Extraction of Retained Guide Wire Fragment**

A. Percutaneous Methods
Double or triple wire technique
Deep wedging of guiding catheter and traction of the system
Retrieval using Balloon inflation technique
Retrieval by snare loop
Retrieval using micro catheter e.g. Tornus catheter
Extraction with Bioptome
Stenting against vessel wall
B. Surgical extraction
C. Conservative therapy

Table 3. The Percutaneous Techniques used to Retrieve Entrapped Wire Fragment

Modality	Number of case (%) Total = 28
Snare loop	9 (32.1)
Double or triple wire technique	3 (10.7)
Deep guide catheter wedge with balloon inflation	6 (21.4)
Tornus micro-catheter	1 (3.6)
Pigtail catheter	1 (3.6)
Stenting against vessel wall	7 (25)
Bioptome	1 (3.6)

If the wire tip could not be freed and the retained fragment is entirely inside the branch, then stenting against the vessel wall might be the option [12, 18]. Percutaneous methods of retrieval are listed in Table **3**.

Surgical Extraction

If percutaneous techniques fail, surgery is warranted. Immediate surgical removal, eventually combined with bypass grafting, should be done. However, the unplanned cardiac surgery is associated with significant morbidity and mortality. Several surgical approaches had been reported for the treatment of retained guide-wire fragments. Bypass surgery is performed in most of the cases. Surgical extraction includes direct coronary arteriotomy or aortotomy [2-5, 8, 29, 31-47].

Left Main (LM) coronary arteriotomy and patch repair has been used for proximal wire entrapment [48].

Medical Management

The attempt to remove retained guide-wire remnants from coronary circulation is the preferable option. Some case reports and case series suggested that in selected patients, a reasonable option might be to leave the guide-wires in-situ without attempting extraction techniques if there is a chance of success seems remote based on the anatomic and technical considerations [1]. Treatment of such patients with systemic anticoagulation and anti-platelets agent with close follow up appears more appropriate for occluded or smaller distal vessels and early surgical referral if ischemic events are encountered.

Complications of Guide Wire Retrieval

Prolonged manipulation of retrieval devices or catheters may increase the risk of thrombus or air embolization. Failure of removal of retained fragments may lead to myocardial ischemia due to coronary thrombosis or obstruction. Vessel dissections or rupture from repeated instrumentation may lead to tamponade or emergency cardiac surgery with associated high mortality.

CONCLUSION

Intervention guide-wire fracture and entrapment is a rare complication of coronary interventions. The operators should be aware of this complication and be familiar with the measures to avoid it and to appropriately manage it.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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ABBREVIATIONS

LM	=	Left Main coronary artery
LAD	=	Left Anterior Descending artery
LCX	=	Left Circumflex artery
OM	=	Obtuse Marginal branch
PDA	=	Posterior Descending Artery
RI	=	Ramus Intermedius artery
RCA	=	Right Coronary Artery
SVG	=	Saphenous vein graft
PCI	=	Percutaneous Coronary Interventions
PTCA	=	Percutaneous transluminal coronary angioplasty

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