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.”

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].
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-cather, 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                                      | Percutaneous retrieval in 2 patients. | Balloon and deep wedging in 2 cases and Surgical extraction in 1 case and conservative in one case |
| 1987   | Hartzlet et al. | 8 patients         | 4 cases RCA 3 cases LCX 1 case LAD | -1 case abdominal aorta                     | - Successful wire extrac- | - Snare loop technique in 3 cases and biopomte technique in one case.                            |
|        |                 |                    |                             |                                             | 3 cases and failed in one case. | - Wire retrieval in one case and conservative in other 2 cases.                                  |
|        |                 |                    |                             |                                             | - Conservative             | - No extraction attempt.                                                                        |
| 1987   | Watson          | 2 patients         | Diagonal branch LCX         | Ascending aorta. Intact wire inside guiding | Percutaneous retrieval and PTCA. | Snaring technique for both cases                                                                  |
| 1987   | Arce-Gonzalez JM| 3 patients         | -2 patients in whom guide wire entrapped in LCX | - Intact wire in first 2 patients | - Percutaneous removal in 2 case | - Deep wedging of guide catheter and balloon then traction of the system as a unit in both case. |
|        |                 |                    | - 1 patient wire entrapped in distal PDA branch of RCA | - Fractured wire extend to descending aorta through SVG to PDA | - Surgical extraction in 1 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                                                                            |
| 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                         | 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  | Gagnon 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                | - Mid LCX                                   | -Stenting against vessel wall  | -Fixation with Stent  |
|        |                   |                    | -Distal PDA (RCA)          | -Distal RCA                                 | -Conservative Therapy         | -Failed retrieval        |
|        |                   |                    | -Mid LCX                   | -Mid LCX                                    | -Stenting                 | -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 Biopctome
- 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)                         |
| Biopctome                         | 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 suggest 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

For LD = Left Descending artery

| Abbreviation | Description |
|--------------|-------------|
| 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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