Journal of the Formosan Medical Association (2015) 114, 1135–1139

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.jfma-online.com

CASE REPORT

A two-case series of entrapment of a ruptured balloon in the coronary artery: Avoidable complications and nonsurgical management

Wei-Ting Chang [a], Ju-Yi Chen [a], Yi-Heng Li, Liang-Miin Tsai, Cheng-Han Lee*

Division of Cardiology, National Cheng Kung University Hospital, Tainan, Taiwan

Received 19 December 2012; received in revised form 2 May 2013; accepted 11 May 2013

KEYWORDS
entrapment;
percutaneous coronary intervention;
retrieval;
ruptured balloon

The entrapment of a ruptured catheter balloon during percutaneous coronary intervention (PCI) is rare, but it can lead to life-threatening complications, such as myocardial infarction (MI) and lethal arrhythmias. Ruptured balloon entrapment usually occurs in either tortuous, calcified, or angulated coronary lesions without adequate balloon deflation. The avoidance of drastic balloon pull-out and the use of appropriate catheter-based retrieval techniques could prevent surgical intervention. Herein, we describe two cases of ruptured coronary balloon entrapment during emergency or elective PCI. We successfully removed the ruptured and entrapped balloons through nonsurgical techniques. Coronary interventionists should be aware of the possibility of balloon entrapment during complex coronary interventions; they should also become familiar with nonsurgical catheter-based methods for the retrieval of ruptured and entrapped balloons.

Introduction

With the increasing prevalence of percutaneous coronary intervention (PCI), even rare complications, such as device entrapment, are becoming a serious problem.[1–8] Both surgical and nonsurgical management have been reported in the literature with the studies individualized to the condition of specific patients and their lesions. In this study, we describe two cases of successful catheter-based retrieval of entrapped

* Corresponding author. Department of Internal Medicine, National Cheng Kung University Hospital, 138 Sheng-Li Road, Tainan 704, Taiwan.
E-mail address: appollolee@hotmail.com (C.-H. Lee).
[a] W.-T. Chang and J.-Y. Chen contributed equally to this article.

0929-6646/$ - see front matter
http://dx.doi.org/10.1016/j.jfma.2013.05.008

and ruptured coronary artery balloons during PCI. We also review the literature in reference to the retrieval of entrapped coronary devices over the past two decades.

Case reports

Case 1

A 78-year-old hypertensive patient experienced acute chest pain within 2 hours of admission to the hospital. A 12-lead electrocardiograph showed inferior ST segment elevation, and the patient was diagnosed with an acute inferior myocardial infarction (MI). An emergency transfemoral coronary angiography showed triple vessel disease with infarct-related right coronary artery (RCA) occlusion (Fig. 1A). After the SCR (Medtronic, Danvers, USA) 3.5 guiding catheter (7F) was engaged, a Fielder hydrophilic wire (ASAHI, Pathumthani, Thailand) was advanced to the distal RCA, and thrombus aspiration was performed at the proximal to mid RCA using Thrombuster II (Kaneka, Osaka, Japan). Balloon angioplasty was performed with a 2.75 × 20 mm Ryujin Plus Balloon (Terumo, Tokyo, Japan) in the proximal RCA at 12 bars, but the balloon ruptured (Fig. 1B). Subsequent angiography showed TIMI (Thrombolysis in Myocardial Infarction) 0 antegrade flow. The patient remained hemodynamically stable. Initially, the balloon catheter could not be removed. The distal balloon marks seemed to be lengthening as we pulled on the catheter urgently. We were under the impression that the balloon had ruptured and was entrapped in the tight lesion. We then used another 2.5 × 20 mm Ryujin Plus balloon inflated within the guiding catheter as an anchoring balloon, but we still could not extract the ruptured balloon. Deep intubation with a 5F ST01 catheter (Terumo, Tokyo, Japan) in a 7F guiding catheter was attempted to cover the entrapped balloon, but the attempt failed. Finally, we intubated the SCR even more deeply to cover the entrapped balloon and successfully removed all devices. We then used the 7F SCR to engage the RCA again. A 3.0 × 24 mm Driver stent (Metronic, Galway, Ireland) was deployed at the proximal RCA after predilatation with a 2.75 × 18 mm Sapphire NC Balloon (OrbusNeich, Hoevelaken, Netherland), a noncompliant balloon, owning better strength and less deformation during inflation than the Ryujin Plus, a semicompliant one. The final coronary angiography showed TIMI 3 antegrade flow in the RCA (Fig. 1C). The post-operative course was uneventful, and the patient was discharged 3 days later.

Case 2

A 48-year-old hypertensive patient with a history of end-stage renal disease underwent routine hemodialysis for 5 years. During 1 recent month, he suffered from crescendo angina and a Thallium scan disclosed a perfusion defect over

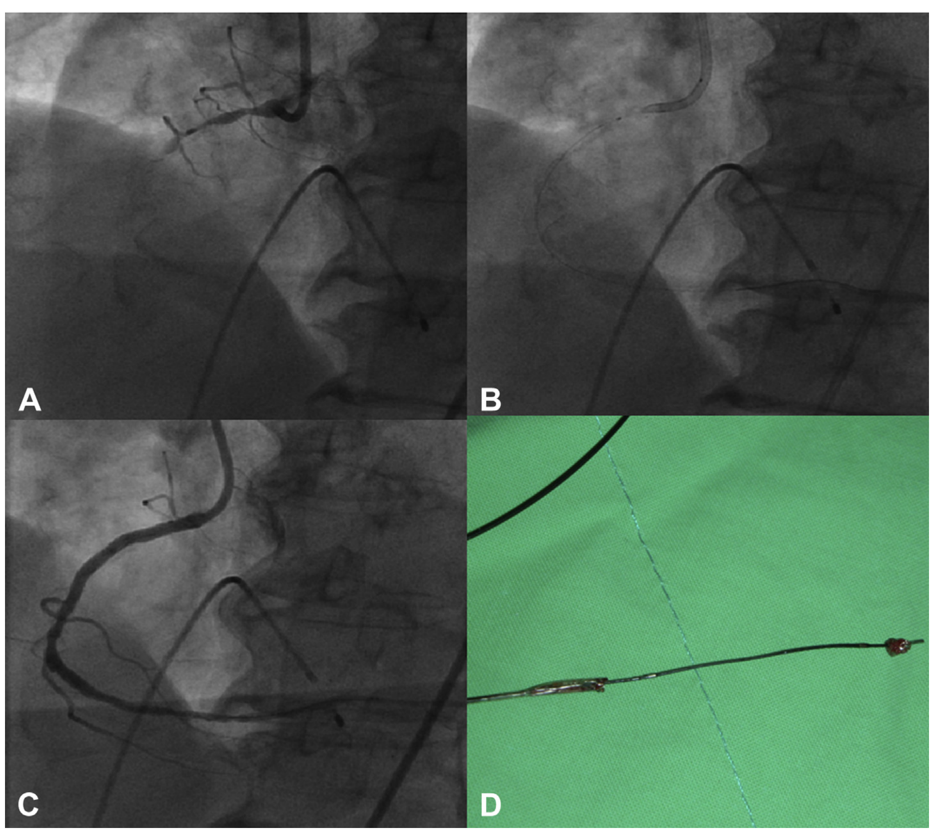

Figure 1 (A) Coronary angiogram from the right anterior oblique (RAO) view showed a total occlusion at the proximal right coronary artery (RCA). (B) The distal portion of the 2.75 × 20 mm Ryujin Plus balloon was entrapped in the proximal RCA. (C). The final coronary angiogram showed TIMI (Thrombolysis in Myocardial Infarction) 3 flow of the RCA after ruptured balloon retrieval and stent deployment. (D) The ruptured balloon was separated to the distal curled part and the proximal uncurled part.

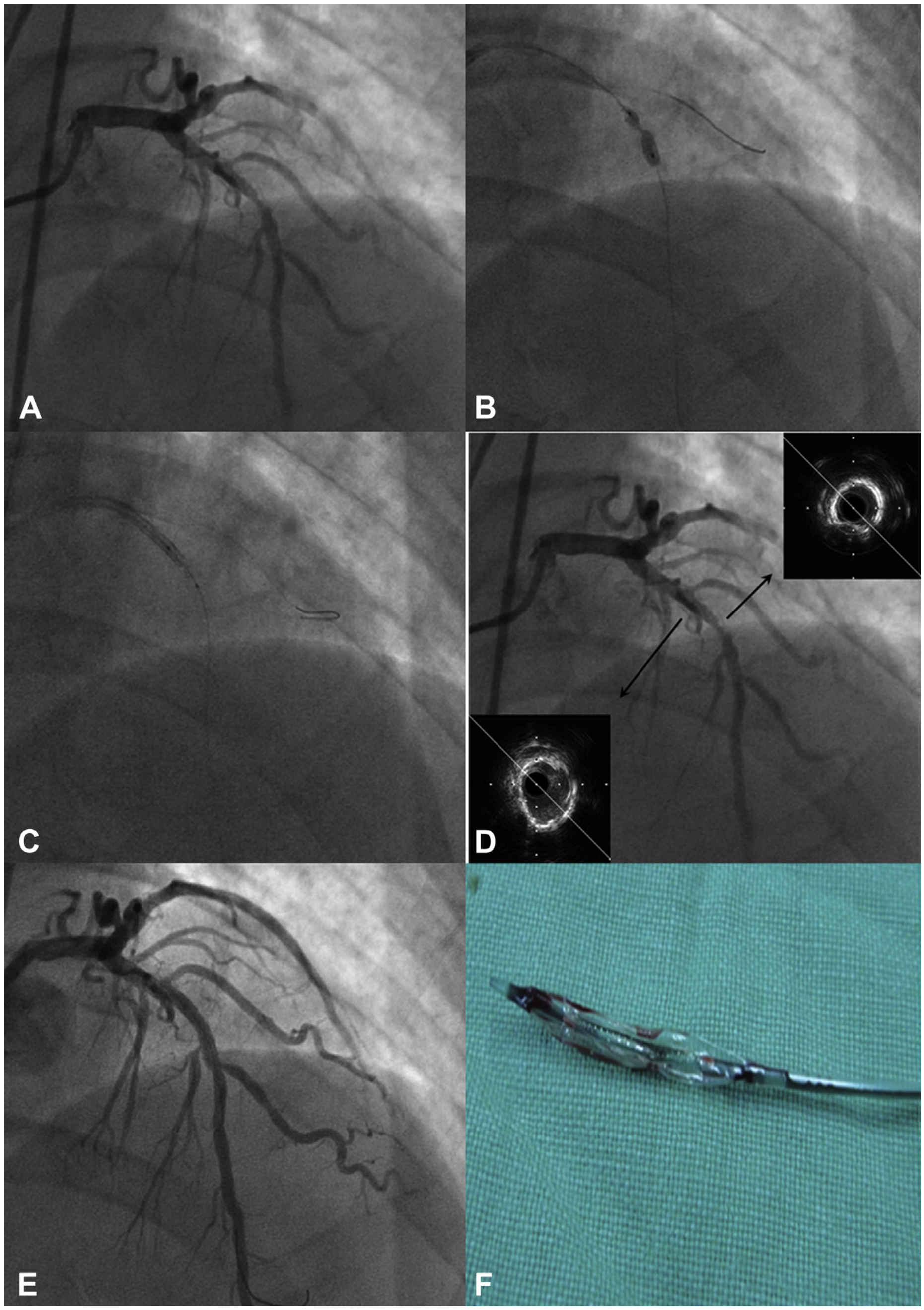

Figure 2 (A) Coronary angiogram from the right anterior oblique (RAO) view showed a 90% stenosis at the mid left anterior descending artery (LAD). (B) A 3.0 × 10 mm IVT cutting balloon failed to fully dilate the lesion and was entrapped. (C) The guiding catheter was deeply intubated to cover the ruptured balloon. (D) Intravascular ultrasound (IVUS) showed a severe 360-degree calcified lesion. (E) The final coronary angiogram showed a well-expanded stent in the mid LAD with TIMI (Thrombolysis in Myocardial Infarction) 3 flow. (F) The retrieved ruptured Flextome Cutting Balloon (Boston Scientific, Galway, Ireland) in vitro.

the apex with reversible redistribution, which implicated the viable myocardium. Thus, he received an elective coronary angiogram. Angiography showed 90% stenosis at the mid left anterior descending artery (LAD) and 50% stenosis at the orifice of the second diagonal branch (D2) (Fig. 2A). A transfemoral coronary intervention was performed using a 7F EBU guiding catheter (Metronic, Danvers, USA) to engage the left coronary artery. A Sion wire (ASAHI, Pathumthani, Thailand) was passed through the LAD lesion, and the other Fielder wire (ASAHI, Pathumthani, Thailand) kept the D2 orifice open. A 2.5 × 15 mm Sprinter Legend Balloon (Metronic, Tijuana, Mexico) was used to predilate the D2 orifice at 8 bars. Attempts to predilate the LAD lesion with both a 3.0 × 15 mm IKAZUCHI (Kaneka, Osaka, Japan) at 12 bars and then a 3.0 × 15 mm Hiryu noncompliant balloon (Terumo) at 20 bars failed. We then used a 3.0 × 10 mm Flextome Cutting Balloon (Boston Scientific, Galway, Ireland) to predilate the lesion at 14 bars. However, the balloon ruptured and was entrapped (Fig. 2B). Owing to the size and the disease-free status of the proximal LAD, we deeply intubated with the guiding catheter to cover the entrapped and ruptured balloon, and the balloon was successfully removed (Fig. 2C). Intravascular ultrasound IVUS (Boston Scientific, Fremont, USA) showed a severe 360-degree calcified lesion where the balloon had ruptured (Fig. 2D). Rotational atherectomy with a rotablator (Boston Scientific, Cork, Ireland) (burr size 1.75 mm and 2.0 mm, sequentially) (Boston, MA, USA) and a noncompliant Hiryu Balloon (Terumo, Tokyo, Japan) fully dilated the lesion, and a 3.0 × 18 mm Promus stent (Boston Scientific, Galway, Ireland) was deployed with full expansion. The final result showed TIMI 3 antegrade flow of the LAD (Fig. 2E). The postoperative course was uneventful, and the patient was discharged the next day.

Discussion

The incidence of entrapped hardware during PCI is reported at a rate of only 0.4–1%.[9] However, entrapped hardware may lead to severe complications, such as systemic thrombosis, coronary perforation, and compromised distal coronary flow.[1–8] We reviewed eight cases of entrapped balloons[1–8] and nine cases of entrapped stents[10–15] from the past two decades (Table 1).[1–8,10–15] Eight cases of entrapment occurred in the LAD,[1,7,10–15] four cases in the RCA,[2,4,5,8] three cases in the LCX,[6,10,14] one case in the left main coronary artery,[12] and one case in the iliac artery.[3] In four cases, the entrapped devices were abandoned *in situ* due to either the generally poor condition of the patient or the chronic total occlusion of the coronary circulation.[8,10] Subsequent coronary angiography revealed no migration of the entrapped devices.[9] Snare retrieval sets were successful in three cases,[3,15] while other catheter-based techniques were successful in two cases.[1,2] Surgical intervention was necessary in the other nine cases, with some patients requiring aortocoronary bypass.[5–7,10,11]

In summary, the entrapment of devices occurs most often in tortuous, angulated, or calcified lesions with sharp edges, especially in lesions involving the proximal portion of the coronary arteries.[4–8] All inflation beyond the rated burst pressure of the coronary balloon, inadequate deflation, and manufacturing defects may increase the likelihood of entrapment. No differences in the rate of device entrapment were noted in any of the following demographics: age, sex, comorbidities, or whether the procedure was elective or an emergency coronary intervention.[9] Some factors leading to entrapment have been reported in the literature, such as the lack of back-up-support guiding catheters, the use of the relatively weaker 0.014 inch wire, incomplete predilatation, and stiffer or longer stents.

Lesions that may present a high risk of entrapment require careful evaluation prior to intervention. In the first case, the application of high-pressure inflation, even under the rated burst pressure, and inadequate deflation, followed by the attempt to quickly remove the balloon, were the cause of the rupture and entrapment. High-pressure inflation with a semicompliant balloon, inadequate deflation, and drastic pull-out of the balloon should be avoided. In the second case, under fluoroscopy, we did not believe that the lesion was so intensely calcified. We first attempted dilation with a semicompliant balloon, then a noncompliant balloon, and finally, with a cutting balloon because the lesion could not be fully dilated. We applied a cutting balloon at high pressure, and the balloon ruptured and became entrapped. IVUS should be routinely used to evaluate complex lesions so that the appropriate devices for lesion dilatation or atherectomy are chosen. When heavily calcified vessels will not dilate with

Table 1 Literature review of entrapped balloons and stents over the past two decades.

Patient no.	Age (y)/sex	Complication	Coronary vessel	Therapy	Reference
1	45/F	Entrapped balloon	LAD	Deeply engage 6F JR4 catheter-based retrieval	1
2	72/M	Entrapped cutting balloon	RCA	Deeply engage 6F JR4 catheter-based retrieval	2
3	69/F	Entrapped cutting balloon	Iliac artery	Loop snare	3
4	65/M	Entrapped balloon	RCA	"Goose neck" microsnare retrieval system	4
5	71/F	Entrapped balloon	RCA	Surgical removal	5
6	69/M	Entrapped balloon	LCX	Surgical removal	6
7	78/F	Entrapped balloon	LAD	Surgical removal	7
8	65/F	Entrapped balloon	RCA	Failed surgical removal	8
9	75/M	Stent dislocation	LAD	No removal + CABG	10
10	77/F	Stent dislocation	LAD	No removal + CABG	10
11	80/F	Stent dislocation	LCX	No removal + CABG	10
12	62/M	Stent dislocation	LAD	No removal + CABG	10
13	39/M	Stent entrapped	LAD	Surgical removal	11
14	65/M	Stent entrapped	LM	Surgical removal	12
15	42/M	Stent entrapped	LAD	Surgical removal	13
16	60/F	Stent entrapped	LCX	Surgical removal	14
17	65/M	Stent entrapped	LAD	Snare device	15

CABG = coronary artery bypass grafting; LAD = left anterior descending artery; LCX = Left circumflex; LM = left main coronary artery; RCA = right coronary artery.

traditional angioplasty, other options, such as a cutting balloon or rotational atherectomy, should be considered. A cutting balloon takes advantage of the reduction in vessel stretch and injury by scoring the vessel longitudinally, rather than an uncontrolled disruption of the atherosclerotic plaque. A cutting balloon is widely applied in *de novo*, instent restenosis, small caliber, and ostial lesions. Rotational atherectomy was designed to debulk lesions and assist in the delivery of stents to the distal location. Lower balloon inflation pressures (4–8 atmospheres) are recommended with a cutting balloon. With high pressure inflation, a cutting balloon may rupture and become entrapped.[3,4]

Surgical intervention is not the only solution for the management of entrapped balloons.[1,2,9] Catheter-based retrieval techniques may save time. Initially, the location of the device fragments and the size of the coronary arteries should be evaluated. The removal of entrapped hardware is not necessarily mandatory. If the device fragments are contained within small, chronically occluded coronary vessels or within a distal segment, it is acceptable to leave the fragments in place or to deploy a new stent directly.[10] However, retrieval is compulsory in the proximal coronary artery, especially in the area that protrudes into the ascending aorta, or in any situation where the coronary flow is compromised to prevent systemic thrombosis. Intracoronary nitroglycerin may assist in the reduction of arterial spasm, but it is of little use in the setting of mechanical complications. Another option is to decrease the balloon viscosity by progressively diluting the contrast material within the balloon with saline: combined with rapid deflation, this method sometimes successfully releases the balloon.[10] The third choice is to deeply intubate the guiding catheter into the artery, along with the anchor system. With this method, however, the patient may be at risk for the dissection of, or even the perforation of, the proximal vessels. With deep intubation, large caliber arteries with minimal tortuosity of the proximal part are crucial, and the patient must be carefully evaluated.[1,2] In the two cases we describe in this paper, we deeply seated the guiding catheter to cover the entrapped balloon and were then able to successfully remove all devices. An alternative method, the daughter-in-mother system, is used to prevent proximal vessel injury. The balloon catheter is transected close to the stopcock, and a small-caliber guiding catheter (e.g., ST 01) is advanced over the original catheter shaft to cover the balloon. Once the balloon is covered, the entire device can be withdrawn. A similar retrieval set was described in 1982.[9] After successful retrieval, except in cases of perforation, intravenous unfractionated heparin (UFH), or even glycoprotein IIb/IIIa receptor blocker, are used to prevent thrombosis formation. The final option for balloon rupture and entrapment is the surgical removal of the device, but this option is often of limited use due to the inevitable time delay. Chang et al[14] suggested that the full extent of the fractured equipment and the verification of possible ostium involvement should be verified fluoroscopically or by transesophageal echocardiography. In the case of any protrusion into the aortic root, which would be a possible thrombogenic source, explosive aortotomy is required. If the retained fragments cannot be easily removed, they should be trimmed within the coronary ostium or retrieved distally through an arteriotomy.[4]

Conclusion

We believe that strategies for the retrieval of entrapped catheter remnants should be individualized for each patient situation. Proper and timely steps without panic are important. Calcified and tortuous vessels should be carefully evaluated, and balloon inflation beyond the rated burst pressure should be avoided. Coronary interventionists should be alert to the possible complications of the entrapment of catheter materials and should be familiar with catheter-based retrieval methods.

References

1. Girish MP, Gupta MD, Tyagi S. Entrapped coronary angioplasty stent balloon due to nondeflation: percutaneous retrieval by a simple technique. *Catheter Cardiovasc Interventions* 2011;**77**:58–61.
2. Blackman D, Dzavik V. Inadvertent detachment of an entrapped Cutting Balloon from the balloon catheter during treatment of in-stent restenosis. *J Invasive Cardiol* 2005;**17**:E27–9.
3. Braun MA, Smith SJ, Merrill TN. Contralateral loop snare removal of a ruptured and entrapped angioplasty balloon. *Cardiovasc Intervent Radiol* 1996;**19**:428–30.
4. Madronero JL, Hein F, Bergbauer M. Removal of a ruptured, detached, and entrapped angioplasty balloon after coronary stenting. *J Invasive Cardiol* 2000;**12**:102–4.
5. Breisblatt WM. Inflated balloon entrapped in a calcified coronary stenosis. *Cathet Cardiovasc Diagn* 1993;**29**:224–8.
6. Nishiwaki N, Kawano Y, Furukawa K. A case report of entrapment of PTCA balloon catheter caused by its rupture. *Nippon Kyobu Geka Gakkai Zasshi* 1991;**39**:1226–30.
7. Chang TT, Pellegrini D, Ostrovsky A, Marrangoni AG. Surgical management of entrapped percutaneous transluminal coronary angioplasty hardware. *Tex Heart Inst J* 2002;**29**:329–32.
8. Carell ES, Schroth G, Ali A. Circumferential balloon rupture and catheter fracture due to entrapment in a calcified coronary stenosis. *Cathet Cardiovasc Diagn* 1994;**32**:346–8.
9. Steffenino G, Meier B, Finci L, Velebit V, von Segesser L, Faidutti B, et al. Acute complications of elective coronary angioplasty: a review of 500 consecutive procedures. *Br Heart J* 1988;**59**:151–8.
10. Alexiou K, Kappert U, Knaut M, Matschke K, Tugtekin SM. Entrapped coronary catheter remnants and stents: must they be surgically removed? *Tex Heart Inst J* 2006;**33**:139–42.
11. Erez E, Herz I, Snir E, Raanani E, Menkes H, Vidne BA. Surgical removal of stent entrapped in proximal left coronary artery system. *Ann Thorac Surg* 1996;**62**:884–5.
12. Fukada J, Morishita K, Satou H, Shiiku C, Koshino T, Abe T. Surgical removal of a stent entrapped in the left main coronary artery. *Ann Thorac Cardiovasc Surg* 1998;**4**:162–3.
13. Karthik S, Silverton P, Blaxill JA, O'Regan DJ. Successful outcome of emergency coronary artery bypass grafting and retrieval of entrapped stent, angioplasty balloon, and guidewire. *Ann Thorac Surg* 2005;**79**:1032–4.
14. Lin TH, Chiu CC, Chen HM, Su HM, Voon WC, Lai WT, et al. An avoidable complication of percutaneous coronary intervention-entrapment of stent and disconnected balloon catheter. *Kaohsiung J Med Sci* 2006;**22**:184–8.
15. Wani SP, Rha SW, Park JY. Entrapment of a drug-eluting stent in left anterior descending artery and left main artery leading to a life-threatening complication. *J Invasive Cardiol* 2010;**22**:E90–2.