Coronary Stent Strut Avulsion and Cutting Balloon Fracture in Treating In-stent Restenosis

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We report an unusual complication of cutting balloon (CB) angioplasty during treatment of aorto-ostial in-stent restenosis. The stent strut was entangled with CB and the stent was extracted partially into the aorta during CB catheter withdrawal, followed by stent and CB catheter fracture. The patient underwent emergency operation for coronary revascularization and device removal. It is important to monitor the stent and CB markers during CB withdrawal, especially when resistance is felt. When strut avulsion occurs with intact CB retrieval, the complication is still salvageable with gentle advancement of the balloon. Another possibly effective way to release the blade from the stent strut is reinflating and deflating the balloon with a slight back-and-forth vibration. However, when balloon fracture occurs, emergent surgical removal is the best solution.

Key Words: Cutting balloon • Stent • In-stent restenosis • Aorto-ostial lesion

INTRODUCTION

With the widespread use of coronary stents, in-stent restenosis (ISR) has become a significant clinical entity. The immediate results of balloon angioplasty for ISR may be good, but long-term outcome is usually poor. Cutting balloon (CB), with microblades bonded longitudinally on the balloon surface, produces sharp and clean incision into plaque during balloon inflation, thus facilitating less traumatic vessel dilatation. CB may be superior to conventional balloon in treating ISR, but specific considerations must be taken.

We present here an unusual complication of CB used for treatment of aorto-ostial ISR in the right coronary artery (RCA). The stent was inadvertently entangled with CB and extracted partially, with subsequent stent and CB catheter fracture. Coronary blood flow was compromised and emergency operation for coronary revascularization and device removal was done.

CASE REPORT

A 62-year-old female patient with a history of left breast cancer status post mastectomy and local irradiation, moderate aortic regurgitation, left subclavian artery stenosis, hypertension, and type 2 diabetes mellitus underwent her first coronary intervention in February 2003. The proximal RCA was successfully stented using a 3.0 × 15 mm BeStent 2 stent (Medtronic, Minneapolis, USA) deployed at 12 atm, without significant residual stenosis or uncovered dissection. Recurrent angina was noted 5 months after stenting, and follow-up coronary angiography in July 2003 revealed 90% diffuse ISR at proximal RCA. The restenotic lesion was successfully dilated to 0% using a 3.0 × 10 mm CB catheter (Interventional Technologies Europe, Donegal, Ireland) at 10 atm. The patient remained asymptomatic for another 5 months. However, angina recurred again in December 2003, and she was admitted for her third coro-
nary angiography.

The diagnostic angiogram revealed recurrent diffuse ISR up to 90% in the proximal part of RCA (Figures 1A to C). 6 Fr JR4 (Cordis, Miami, USA) guiding catheter and 0.014” Rinato wire (Asahi Intecc, Aichi, Japan) were chosen, and the lesion was carefully crossed without noticeable difficulty. A 3.0 × 10 mm CB catheter was then advanced without resistance, and 2 slow inflations up to 10 atm with full balloon expansion were performed (Figures 1D, E). After complete deflation, significant resistance was encountered upon withdrawal of the CB back to the guiding catheter (Figure 1F). Withdrawal of the guiding and CB catheters as a unit was carried out, and the paired markers of CB were noted to be separated from each other. The paired edge markers of the BeStent 2 stent were also departed from each other (Figures 1G, H). After forceful retraction, the CB catheter fractured and the proximal part of the balloon was retrieved in the shaft. The distal part of CB remained in the proximal RCA, as indicated by the immobile distal markers under fluoroscope (Figure. 1I). The patient complained of severe chest pain with coronary blood flow diminishing to TIMI 0, and she was sent for emergent surgery.

Transesophageal echocardiography after general anesthesia showed a highly echogenic object protruding from the RCA into the aortic root (Figure 2A, 2B) and moderate to severe aortic regurgitation. The retained CB and entangled stent were removed manually as a unit via aortomy (Figure 2C). Coronary bypass grafting and aor-

Figure 1. Coronary angiogram during CB angioplasty. (A-C) Tight ISR at the orifice of RCA. White arrows indicate the edge markers of the BeStent 2 stent. (D-E) Inflations of 3.0×10 mm CB with full balloon expansion. (F) Fluoroscopy when resistance was felt during CB withdrawal after deflation. (G) Stent fracture and avulsion by CB. White and black arrows indicate the paired stent edge markers and CB markers, respectively. The proximal part of the stent was dislocated and pulled into the guiding catheter. (H) CB fracture. With a sudden release of resistance during forceful withdrawal, markers of CB were noted to be separated. (I) Final result after partial retrieval of CB catheter. The distal CB marker remained in RCA (black arrow), and coronary flow was compromised.
cic valve replacement were performed smoothly, and the patient was discharged uneventfully after operation. Examination of the removed mass revealed disrupted stent struts with proximal gold edge marker, entangled with the distal part of the fractured CB catheter. The stent strut was caught by the proximal edge of a microblade (Figure 2D), and the microblades on CB were not fractured.

**DISCUSSION**

Recent histopathological and intravascular ultrasonic studies have identified smooth muscle cell hyperplasia as a fundamental component of ISR. Therefore, tissue-ablative modalities such as directional coronary atherectomy (DCA) and rotational atherectomy (RA) have been proposed for ISR treatment. However, clinical results of DCA and RA were disappointing. Though not considered as an athero-ablative modality, CB angioplasty achieved greater acute gain and less late loss compared to conventional balloon angioplasty, especially when treating ISR. The greater capacity to extrude neointimal tissue outside the stent may be the main mechanism. However, CB angioplasty still has limitations. One major disadvantage is the presence of stiff microblades, which cause CB to be more rigid and less trackable. Therefore, the operator often experiences excessive resistance during balloon advancement. However, as in this case, this expected resistance may be a sign of serious complication.

The presented case is the fifth case in the literature reporting stent strut damage and extraction complicating CB angioplasty for ISR. The proposed mechanisms included inadvertent passage of CB through a protruding stent cell, microblade fracture, oversized CB, and anchoring of a microblade with stent edge. In this case, the latter was the most possible reason. Acute angle between the proximal RCA and aorta, and previously implanted ostial stent, both led to poor alignment of CB catheter with the vessel axis. The rigid microblade could be caught by the stent strut easily when the CB catheter

![Image](image-url)
was pulled. This might explain the relatively higher incidence of this complication occurring at RCA orifice.\textsuperscript{7-10} Inadequate strut apposition or stent under-expansion might also lead to this complication. As intravascular ultrasound (IVUS) was not performed in this case, stent mal-apposition could not be ruled-out, even with the good angiographic results from previous interventions. However, routine IVUS after stent implantation or prior to ISR intervention still warrants cost-effectiveness evaluation.

The edge markers of the BeStent 2 stent are very useful for accurate stent positioning, especially in ostial lesions. In this case, the increasing distance of the paired markers during CB withdrawal gave the first warning sign of stent deformity. Careful monitoring of the stent and CB balloon markers is important when resistance is felt during CB withdrawal. When strut avulsion occurs with intact CB retrieval, the complication is still salvageable with gentle advancement of the balloon.\textsuperscript{10} This maneuver should unlock the microblade and the stent strut and reduce the risk of stent avulsion. Another possibly effective way to release the blade from the stent strut was reinflating and deflating the balloon with a slight back-and–forth vibration.\textsuperscript{8} However, when balloon fracture occurs, as noticed by the separation of CB markers in this present case, emergent surgical removal is the best solution.

In conclusion, we have presented a rare but potentially catastrophic complication of CB angioplasty in treating ostial RCA ISR. Stent strut entanglement with CB was noted and forceful retrieval resulted in fracture of stent as well as CB catheter. Precautions need to be taken when treating ISR with CB catheter, especially in ostial location.

REFERENCES


治療血管支架再狹窄時所發生之刀片氣球斷裂及支架扯裂之併發症

林彥宏1 林昭維1 許榮彬2 黃啟祥3 高憲立4
雲林縣 台大醫院雲林分院 內科1
台北市 台大醫院 外科2 麻醉科3 內科4

我們報告使用刀片氣球治療主動脈側開口支架內狹窄的一個罕見併發症。在進行治療時，刀片氣球卡住支架網眼；且當刀片氣球回收時部份支架被扯入主動脈內；然後發生刀片氣球斷裂的情況。病人接受緊急冠狀動脈繞道手術以及移除殘留之刀片氣球及支架。在刀片氣球回拉時注意支架及刀片氣球上之標記是很重要的，尤其是感覺到有阻力時。當支架扯裂但刀片氣球仍為完好的時，可嘗試小心的將氣球往前推以解決問題；另一個可能有效使刀片脫離支架的方法為再次的撐開及放鬆氣球並輕輕的前後震動。但當刀片氣球已經斷裂，緊急手術是最好的方法。

關鍵詞：刀片氣球、支架、支架內狹窄、主動脈側開口病灶。