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Case Report

Stent Fracture Immediately after Placement of PROMUS Element® Stents to a Severely Tortuous Right Coronary Artery

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ABSTRACT

A 47-year-old man with familial hypercholesterolemia and multivessel coronary disease was treated to alleviate a narrowing of the severely tortuous mid-portion of the right coronary artery. Platinum-chromium everolimus-eluting stents (PROMUS Element® stents) were placed under the guidance of intravascular ultrasonography, overlapping with a total stent length of 70 mm. However, immediately after the stents were placed, disruption and tear stent fractures were detected with angiography and intravascular ultrasonographic assessment, which showed a lack of circumferential and partial stent struts. One month later, the StentBoost imaging enhancement technique clearly showed stent fracture. After 1 year angiography showed no in-stent restenosis or avulsion stent fracture, a more complex stent fracture. After 2 years no clinical target vessel failure had occurred. Thus, this case provides direct evidence of stent fracture without a more complex stent fracture or symptomatic stent failure when everolimus-eluting stents are placed in the severely tortuous mid-portion of the right coronary artery. (Jikeikai Med J 2015 ; 62 : 73-8)

Key words : everolimus-eluting stent, stent fracture

INTRODUCTION

The everolimus-eluting stent (EES), the present second-generation drug-eluting stent (DES), has shown clinical outcomes promisingly better than those of the sirolimus-eluting stent (SES), a widely used first-generation DES[1]. The clinical improvement from the SES to the EES has been due to the overall beneficial effects of the drug, the polymer, and the revised stent platform[1]. However, although the fracture rate of EESs has decreased since their platforms were revised[2], stent fracture remains the main cause of adverse clinical outcomes, including stent thrombosis and angiographic in-stent restenosis, of EESs[2] and of SESs[3-6]. Therefore, to further increase the clinical success rate of EESs, the clinical and angiographic implications of cases of stent fracture after EES placement should be evaluated.

We observed a case of stent fracture immediately after placing a PROMUS Element® stent (Boston Scientific Corp., Marlborough, MA, USA), a platinum-chromium EES, for a severely tortuous lesion in the mid-portion of the right coronary artery (RCA), detected with angiography and intravascular ultrasonography (IVUS). One month after percutaneous coronary intervention (PCI) was performed, stent fracture was detected with the StentBoost visualization technique (Philips Healthcare, Best, The Netherlands)[7]. Thus, we report the results of the procedure with the diagnosis of stent fracture with angiography[8], IVUS[9], and the StentBoost technique ; the 1-year angiographic outcome with no occurrence of in-stent restenosis ; and a

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2-year clinical follow up without symptomatic stent failure.

CASE

A 47-year-old man who had de novo angina with exertion requested multislice computer tomography for the screening of coronary stenosis in February 2013. The multislice computer tomography performed in February 2013, showed triple-vessel disease, with severe stenosis in segment 6 and diffuse moderate stenosis in segment 7 of the left coronary artery, severe stenosis in segment 14 in the mid-portion of the left circumflex artery, and severely tortuous diffuse stenosis in the mid-portion (segment 2) to the distal portion (segment 3) of the RCA (Fig. 1A and B). Because of the severe triple-vessel disease with severely tortuous lesions in the RCA of a patient with multiple risk factors, including familial hypercholesterolemia, we recommended a surgical operation with a coronary artery bypass graft for complete revascularization. However, the patient refused the coronary artery bypass graft, and, according to his request, PCI was planned.

In April 2013, PCI of the RCA was performed with the buddy wire technique (Fig. 1C). The accordion phenomenon was observed during the procedure (Fig. 1C–G). The lesion length, estimated with quantitative coronary angiography, under the buddy wire technique (66.91 mm) was shorter than that measured after the overlapped stenting procedure (73.77 mm). According to the IVUS assessment (Fig. 2B–F), EESs were placed with an overlap (3.0×38 [Fig. 1D] and 3.0×32 mm [Fig. 1E]) from the distal segment 3 to the proximal segment 2 (Fig. 2B). Angiography after placement of the EES (3.0×38 mm) to segment 3 (Fig. 1D) and the IVUS assessment (Fig. 2C and D) showed the necessity of additional stenting for the severely tortuous proximal lesion. Just after the second EES (3.0×32 mm) was placed to segment 2 (Fig. 1E), stent fracture (disruption) was observed (Fig. 1F). At first, the balloon (3.5×15 mm) could not pass through the site of stent fracture in segment 2, but after being inflated at the proximal site inside the stent the balloon could be passed through to segment 3. Indentation was observed at the site of the torturous lesion (Fig. 1E). The IVUS assessment showed the lack of a circumferential stent strut (Fig. 2H), with the bare area fully covered by the longitudinal struts (Fig. 2I), and a lack of the strut partially for more than half of the circumference (Fig. 2J). The final angiogram showed that the angulation of the RCA was changed before stenting (Fig. 1G).

In May 2013, the StentBoost visualization technique was performed with the imaging of 18 ordinate frames before PCI of the left coronary artery (Fig. 3A and B). This visualization revealed 2 types of stent fracture (disruption and tear). From the motion of the stent and the native coronary, the stent fracture would have been formed by longitudinal compression and elongation as it conformed to the tortuous lesion (Fig. 3B).

In April 2014, follow-up secondary angiography was performed to determine if asymptomatic in-stent restenosis had occurred. Intermediate stenosis at the mid-portion of the EES at the severely tortuous site was observed (Fig. 4A–C). The tortuosity and angulation of the RCA were greatly returned (Fig. 1 and 4). The percentage diameter of stenosis was 42, and the total stented lesion length was 64.2 mm. Complex stent fracture, such as avulsion, was not observed with angiography.

During the 2-year follow-up period in February 2015 the patient did not experience any clinical chest symptoms as an outpatient.

DISCUSSION

The stent fracture rate of the platinum-chromium EES (PROMUS Element® stent) has decreased since their platforms have been revision[2,10]. Therefore, this EES was used for the present targeted lesion because of its greater benefit than the cobalt-chromium EES[10]. However, in the present case, stent fracture was diagnosed with angiography (Fig. 1F)[8] and IVUS (Fig. 2B and D)[9] immediately after EES placement and was detected with the StentBoost technique[7] approximately 1 month after the index procedure (Fig. 3B). To our knowledge, the present case is the second to show a disruption-type stent fracture immediately after a DES was placed[11] and the first reported case of stent fracture immediately after a second-generation DES was placed.

The long, overlapped EESs of the present case underwent several types of mechanical stress made in stent fracture, although the exact time frame of stent fracture development was difficult to determine. First, an intense, longitudinal, and mechanical stress triggered stent fracture immediately after the ESS was placed. The placement of

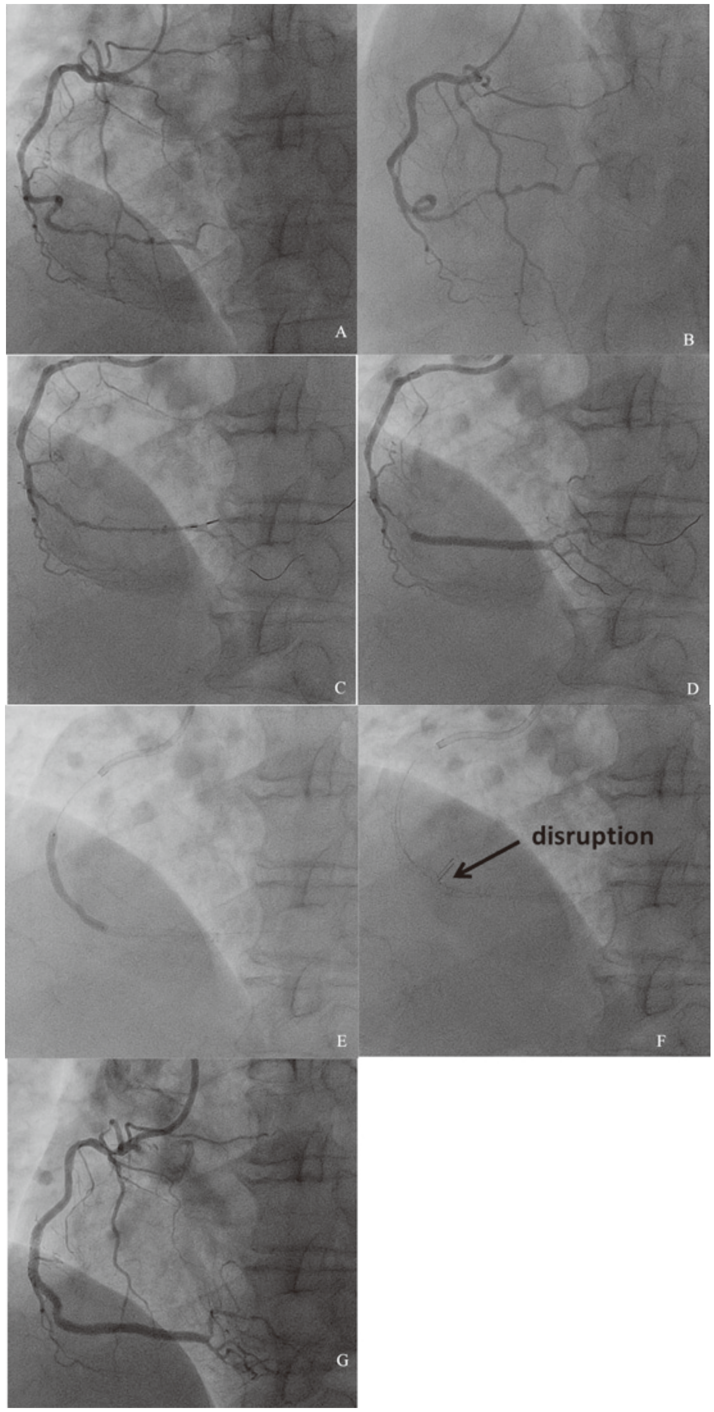

Fig. 1. Coronary angiography and percutaneous coronary intervention procedure
(A) Coronary angiogram showing the severely tortuous mid-portion and diffuse severe stenosis of the right coronary artery (left anterior oblique [LAO] view). (B) Coronary angiogram of the right coronary artery (LAO cranial view). (C) Intravascular ultrasonographic assessment at distal section 3 with buddy wire technique. (D) Angiogram after primary everolimus-eluting stent (EES) (3×38 mm long) placement with 12 and 16 atmospheres. (E) Placement of secondary EES (3×32 mm long) with 16 atmospheres. (F) Disruption of EES immediately after placement. Stent fracture (disruption) is indicated by arrow (corresponding to Figures 2H and 3). The dashed lines show the distance of the struts. (G) Final angiogram (LAO view).

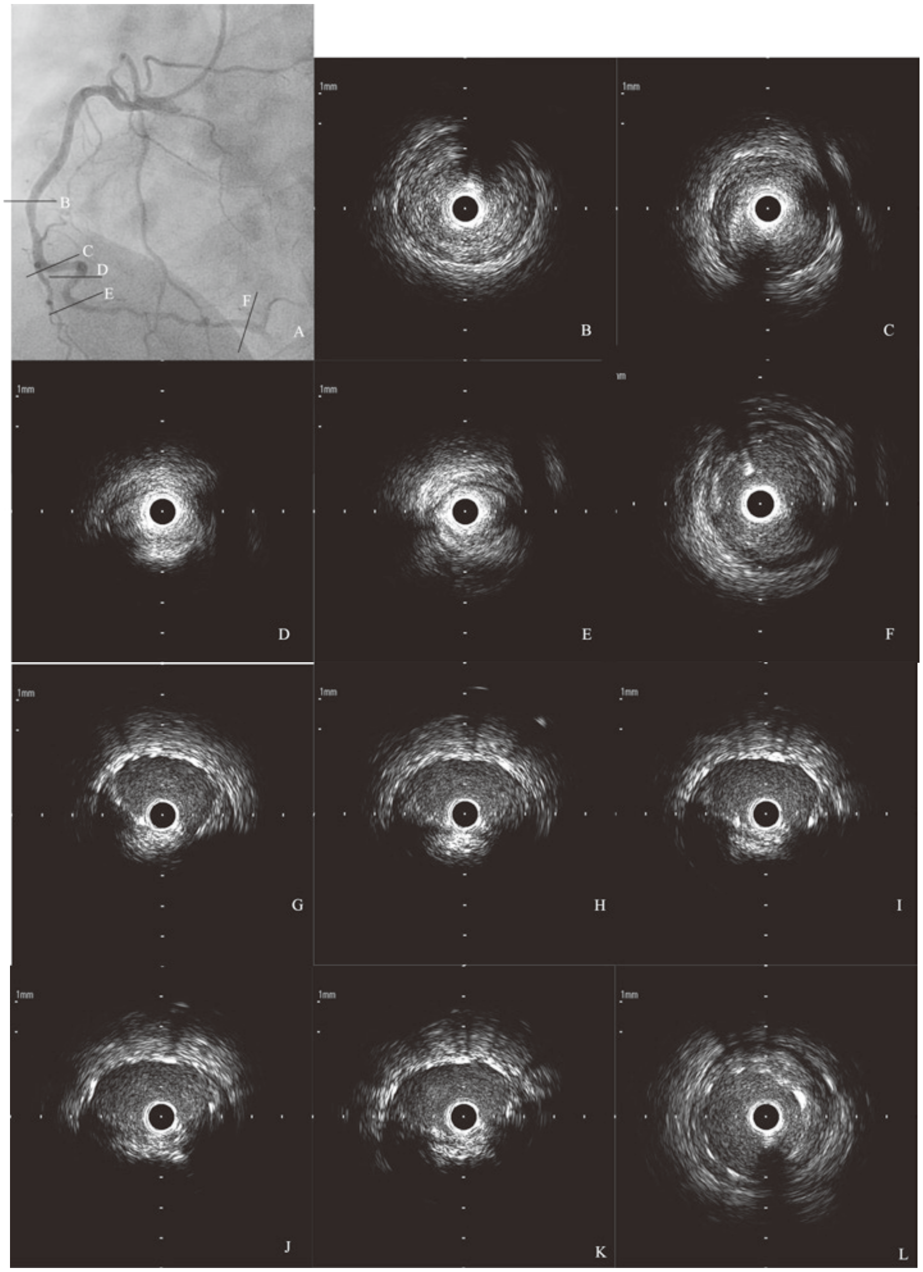

Fig. 2. Intravascular ultrasonographic images before stenting and after postdilation of everolimus-eluting stent (EES) placement (A) Angiogram before stenting indicating the 5 sites corresponding to the intravascular ultrasonographic findings of B to F. (B) Proximal stent landing site. (C) Proximal site of tortuous lesion. (D) Mid-portion of tortuous lesion. Vessel reference diameter was smaller than in Figures 2B, 2C, and 2F. (E) Distal part of tortuous site. (F) Distal section 3 was decided for the distal part of the stent. (G) Proximal site of EES placement corresponds to Figure 3B. (H) Lack of circumferential stent strut, corresponding to the disruption site (Figures 1F and 3B). (I) Full coverage by the strut just distal from the disruption site. (J) Lack of the strut more than half of the circumferential lumen, corresponding to the tear site (Figure 3B). (K) Full coverage by the strut at distal part of tortuous lesion, corresponding to Figure 2E. (L) Distal site of EES placement corresponding to Figure 2F.

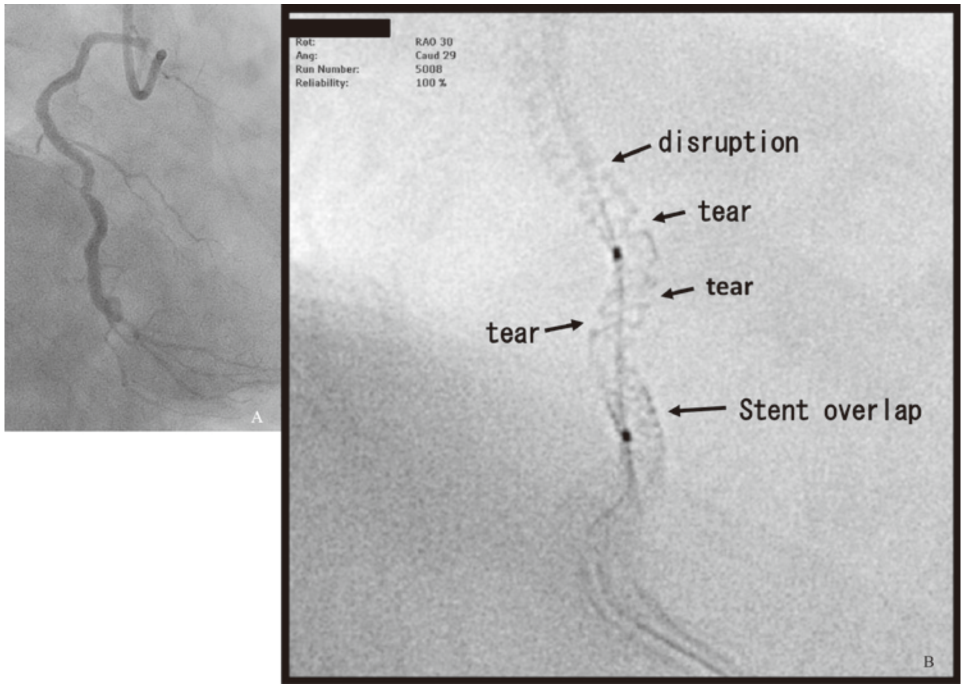

Fig. 3. StentBoost image 1 month after everolimus-eluting stent placement
(A) Right anterior oblique caudal view of the right coronary artery approximately 1 month after stenting. (B) StentBoost image 1 month after everolimus-eluting stent placement. Clearly visible are stent fractures (disruption and tears : black arrows).

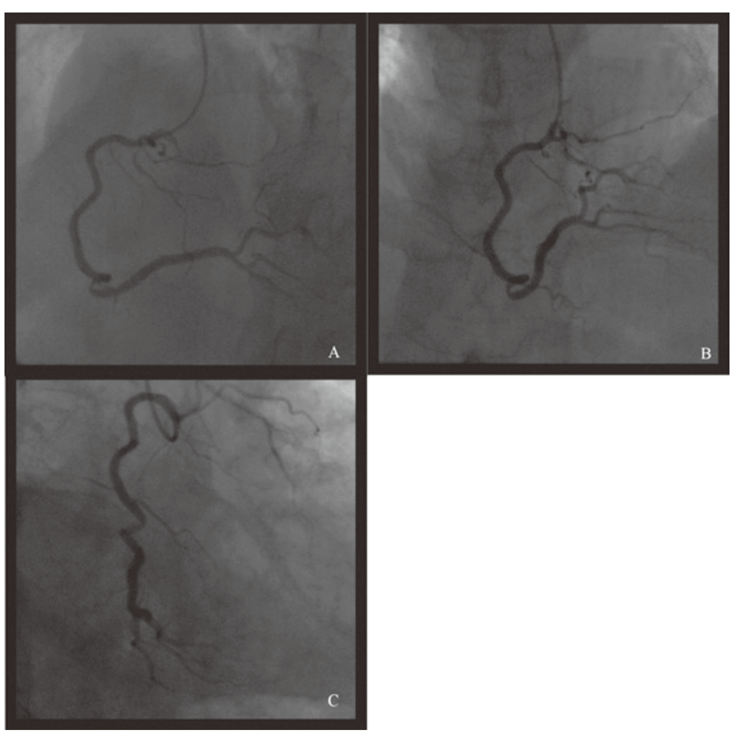

Fig. 4. Follow-up secondary angiogram
One-year follow-up angiograms of the right coronary artery in the left anterior oblique view (A), straight cranial view (B), and right anterior oblique caudal view (C).

the EESs was complicated by the accordion phenomenon (Fig. 1C). Quantitative coronary angiographic analysis showed that the length of the lesion under the accordion phenomenon decreased by 10.3% before the EESs were placed along the tortuous lesion. This instantaneous change in the length of the EESs immediately after being placed would cause stent fractures (disruption and tear) by a compressing and stretching effect on the EESs (Fig. 3B). After the stent fracture developed immediately after the EESs were placed, a longitudinal mechanical stress would have been continuously in place because of the change in EES length. Second, re-elongation and re-dilation of the EES by the oversized balloon with indentation along the tortuous lesion might have induced the additional stent fracture. This ballooning was, however, necessary to rescue the EES after stent fracture developed. An additional EES was not placed because there were several factors for stent fracture and in-stent restenosis, such as small lumen diameter, multiple long stenting, oversized ballooning, RCA, hinge motion, and tortuosity[3-6], and an additional EES would increase the risk of further narrowing of the lumen. Third, at severely tortuous sites, complex 3-dimensional mechanical stresses will always develop after stenting. The main reason for the stresses is the motion of the mid-portion of the RCA in the regular cardiac cycle.

The angiographic follow-up examination 1 year later appeared to show that the tortuosity of the RCA returned to the level before stenting. The sites of disruption and tear stent fracture were not indicated in the angiographic in-stent restenosis (Fig. 4A-C). Those stent fracture-related factors in the tortuous site did not induce avulsion, the more complex type of stent fracture[8] more frequently observed after a Cypher Bx Velocity® stent (Johnson & Johnson Services, Inc., Miami, FL, USA) is placed. The lack of avulsion with the EES would be due to its good vessel conformability, radial strength, and fracture resistance. In addition, the lack of a complex stent fracture might be the underlying reason that EES shows a better clinical outcome beyond 1 year after placement compared with SES[1]. However, further long-term observation should be continued, because several stent fracture-related factors remained in severe tortuous lesions in the RCA, as described above.

In summary, we have reported a rare case of stent fracture developing immediately after a long, overlapped EES was placed in a severely tortuous mid-portion of the RCA. However, stent fracture of a more complex type was not shown with angiography after 1 year, and symptomatic stent failure was not shown after 2 years.

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