CASE REPORT

Delayed Endothelialization After Polytetrafluoroethylene-Covered Stent Implantation for Coronary Aneurysm

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A polytetrafluoroethylene (PTFE)-covered stent is specially used to treat coronary perforation complicating percutaneous intervention in order to prevent the aneurysm from rupturing, but until now it has not been known if endothelialization occurs inside this type of stent. A patient with a giant aneurysm of the right coronary artery underwent successful implantation of a PTFE-covered stent. Angiography at 9-month follow-up showed focal restenosis at the proximal edge of the stent and coronary angiography revealed restenosis as a result of thrombus formation. Absence of endothelialization in the covered stent was also detected by angiography and optical coherence tomography. These findings suggest that in-stent thrombosis must be prevented after PTFE-covered stent implantation. (*Circ J 2009; 73: 190–193)

Key Words: Aneurysm; Restenosis; Stents; Thrombus

Case Report

A 65-year-old man with hyperlipidemia, hypertension, and a history of inferior myocardial infarction was admitted because of chest oppression. Coronary angiography showed a giant aneurysm in the distal right coronary artery, so a PTFE-covered stent (3.5x19 mm, JOSTENT Graft Master™, Abbott Vascular Instruments, Abbott Park, IN, USA) was deployed to seal it. Distal bifurcated lesions were treated with 2 standard stents (3.5x24 mm and 3.5x12 mm, Express²™, Boston Scientific, Natick, MA, USA) using the Y-stent technique (Fig 1). The patient did not complain of chest symptoms and received continuous dual antiplatelet therapy and warfarin during the follow-up period. Although 64-slice MDCT at 4 months revealed no enhancement of contrast medium in the aneurysm, it was uncertain whether or not there was restenosis in the covered stent, so at the 9-month follow-up cardiac catheterization was performed. A focal restenosis at the proximal edge of the covered stent was found on angiography, so the whole segment of the covered stent was evaluated by angioscopy and optical coherence tomography (OCT). Angioscopy showed white thrombus protruding into the lumen and none of the struts was visible at the proximal edge of the stent. A small, red thrombus and exposed struts were observed in the middle of the covered stent, whereas the struts of the standard stents were completely covered by white neointima and were invisible (Fig 2). The OCT image of the proximal edge of the stent

Fig 1. Coronary angiograms taken before and immediately after percutaneous intervention for an aneurysm. (A) Giant aneurysm (10 mm in diameter) in the distal right coronary artery (arrow). (B) After polytetrafluoroethylene-covered stent deployment, the aneurysm is sealed and completely disappears from view. Bifurcated stenotic lesions are treated by Y-stenting with 2 standard stents.
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Fig 2. Follow-up imaging. (A, B) Follow-up 64-slice MDCT 4 months after polytetrafluoroethylene (PTFE)-covered stent implantation shows no contrast medium in the aneurysm. Restenosis in the covered stent is indistinct. (C) Angiogram from 9-month follow-up reveals focal restenosis at the proximal edge of the PTFE-covered stent (arrow). (D) On angioscopy there is a protruding white thrombus at the restenotic lesion (arrow). (E) In the middle of the covered stent, struts can be clearly seen on angioscopy and appear to be exposed. A small red thrombus is attached to the exposed strut (arrow). (F) In the segment distal to the covered stent, the 2 standard stents are completely covered by white neointima with a smooth surface and their struts are not visible.

Fig 3. Optical coherence tomographic images of the polytetrafluoroethylene-covered stent. (A) At the proximal edge of the stent, the narrowed lumen has an irregular surface, whereas in the middle of the stent it is wide (B). (C, D) Magnified insets of (B) show persistent exposed struts (arrowheads) and a thin membranous structure (≤100 μm thick) with a smooth surface inside the struts (arrows). (E, F) Struts of the standard stents are completely covered by thick neointima in the overlapping stent segment (E) and in the single stent segment (F).
showed luminal narrowing with an irregular surface and there were several exposed struts in the middle of the stent, whereas a very thin layer of endothelialization was visible on the other struts. In the overlapping segment and single-stent segment of the standard stents, thick neointima fully covered the struts (Fig.3). Quantitative analysis by OCT is shown as Table I. The measured neointimal hyperplasia (NIH) area, percent NIH area (NIH area/stent area ×100), and NIH volume of the polytetrafluoroethylene (PTFE)-covered stent were smaller than those of the standard stents. Balloon angioplasty for the restenosis was successful.

**Discussion**

Limited angiographic follow-up data after PTFE-covered stent implantation show that restenosis and thrombotic occlusion often occur in the stented segment1-3 but to date the extent of endothelialization in the PTFE-covered stent has been unknown. Coronary angioscopy and OCT can evaluate neointimal growth or endothelialization on the stent struts and ascertain the presence of in-stent thrombi4-11. In the present case, a protruding white mass was found at the lesion of angiographic restenosis. Generally, early thrombosis involves platelets and fibrin, so a primordial thrombus has a white, cotton-like appearance. Subsequently, erythrocytes attach to the platelet-rich thrombus and change its color to red. In the process of thrombus organization, the color changes from red to pinkish-white and white10. Protruding white neointima is frequently seen at the restenotic lesion after catheter intervention. Although the neointimal surface is usually smooth, in the present case the mass at the proximal edge of the PTFE-covered stent had an irregular surface without the cotton-like appearance, which confirmed it was an organized white thrombus based on the angioscopic findings.

OCT identified a thin membranous structure inside the PTFE-covered stent, but even with high-resolution OCT images it can be difficult to diagnose precisely the nature of such a structure. On OCT images a fresh, red or white thrombus is usually defined as an irregular high- or low-backscattering mass protruding into the lumen. The signal intensity of the surface and degree of signal attenuation can distinguish a red thrombus from a white thrombus;11 however, in the present case, the structure was extremely thin, which prevented evaluation of it as a thrombus or other kind of tissue, such as neointima with endothelium, or fibrin. Moreover, OCT criteria for an organized thrombus have not been established. Angioscopy also cannot discriminate between thin neointima and a layer of fibrin, although it is most likely that fibrin deposition would appear as a shaggy surface on OCT4,8 Therefore, a membranous structure with a smooth surface may indicate endothelialization within the PTFE-covered stent.

Although all the tissue inside the stent might not be neointima, the area of NIH and its volumetric analysis were both smaller for the PTFE-covered stent than for the standard stents. Furthermore, angioscopy and OCT identified uncovered struts only in the PTFE-covered stent. In other words, delayed endothelialization of the PTFE-covered stent was detected by 2 imaging modalities, as occurs with drug-eluting stents also4-8. However, the mechanism of delayed endothelialization in the PTFE-covered stent may differ from that in drug-eluting stents, it is possible that the PTFE tube interferes with endothelialization and neointimal proliferation derived from migration of smooth muscle cells via the space between the strut struts. On the other hand, it is interesting that partial endothelialization in the covered stent was confirmed by high-resolution OCT images, a phenomenon that may be explained by mobilization of circulating endothelial progenitor cells from the bone marrow into peripheral blood to contribute to endothelialization inside the covered stent despite the outer PTFE tube.12

Regarding the angiographic and clinical outcomes, a previous investigation using PTFE-covered stents in various clinical settings reported that subacute stent thrombosis occurred in 5.7% of the patients. Angiographic restenosis of the PTFE-covered stent was found in 31.6% and was mainly localized at the stent edge (29.8% stent edge, 8.8% stent center) The RECOVERS trial results indicated that PTFE-covered stents implanted in saphenous vein grafts showed a higher incidence of 30-day subacute myocardial infarction than standard stents (10.3% vs 3.4%, respectively)3. As those reports show, the incidence of subacute thrombosis and restenosis in the PTFE-covered stent is relatively higher than in standard stents, which may be related to delayed endothelialization and increased susceptibility to thrombus formation in these stents. Moreover, the angiographic restenosis lesion may contain thrombus, as indicated by our angioscopic observations. Despite the fact that there is no consensus on the appropriate duration of antiplatelet and anticoagulant therapies after PTFE-covered stent implantation, our images suggest that special care should be paid to preventing stent thrombosis when using this type of stent.

**References**

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