Directional Coronary Atherectomy as Coronary Pathohistology

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Optical coherence tomography (OCT) is mainly used for quasi-pathological assessment of coronary plaques. However, it is not a perfect substitute for pathological evaluation, and we should continue attempting to increase its accuracy by comparing OCT findings and obtaining samples of lesions for histology, which is usually accomplished by autopsy.

Directional coronary atherectomy (DCA) catheters have been the classic interventional device which removes targeted stenosis in a coronary artery. DCA can resolve the stenosis in a coronary artery. In addition, it can also harvest plaque tissues as well as enable direct histopathological assessment of the lesion, unlike OCT.

DCA was more commonly used in the bare-metal stent (BMS) era. Several reports have discussed the histopathological characteristics of DCA-harvested samples in in-stent restenosis (ISR) lesions, which mainly consisted of intimal proliferation and extracellular matrix, with or without fibrous and proinflammatory atherosclerotic plaque and thrombi. However, the histopathological characteristics of DCA-harvested plaques among patients with drug-eluting stents (DES) were not established because DCA is no longer being used in the recent DES era.

In the DES era, Otsuka, et al described the pathohistology of 204 DES lesions by autopsies. They reported that the frequencies of uncovered stent struts by endothelial cells, struts with fibrin deposition, and struts with giant cells were significantly less in lesions with second-generation cobalt-chromium DES than in those with first-generation DES. The frequencies of eosinophilic inflammation and hypersensitivity reaction also seemed to occur less frequently in the second-generation DES group. On the other hand, neoatherosclerotic changes including foamy macrophage clusters, fibroatheroma, thin-cap fibroatheroma (TCFA), or in-stent plaque ruptures were also observed in the second-generation DES group. Like these recent reports, pathohistological evaluation is mainly undertaken by autopsy. As a result, quasi-pathological assessments including OCT are commonly used. (Figure)

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Tsuji, et al. described the discrepancy between the general understanding that diffusely bordered and rapidly attenuated regions detected by OCT suggest lipid-laden plaque and the histopathological assessment of neoatherosclerotic plaque. Fujii, et al. directly compared OCT, intravascular ultrasound (IVUS), and histopathological assessment by autopsy to determine if these different methods have the same results in the same coronary plaques in *ex vivo* experiments. They reported the positive predictive value of TCFA by OCT was 41%. Large amounts of foamy macrophages, microcalcification, hemosiderin, or organized thrombus were incorrectly assessed as TCFA by OCT. Heterogenous ingredients of neoatherosclerotic plaques are supposed to be one of the reasons for this low predictive value, while its negative predictive value was 100%.

According to Tsuji, et al., unexpectedly, DCA devices showed potential as intravascular biopsy devices. Hoshino, et al. reported a comparison of findings of unstable coronary lesions after DES implantation, assessed by DCA, not an autopsy. IVUS can detect an intraplaque hemorrhage as an image like a clearly bordered and crescent-shaped low-signal region adjacent to the calcification as previously reported. However, it had been unknown whether OCT could detect an intraplaque hemorrhage or not. Hoshino, et al. clearly showed that a specific OCT image could reflect an intraplaque hemorrhage in such a way that DCA produced tissue samples sent to pathology. In this manner, DCA is a re-emerging tissue biopsy technique which can validate quasi-pathological assessments like OCT, virtual histology, and IVUS.

Of course, DCA has several limitations. First, DCA use has decreased due to its high frequency of coronary perforation and its small contribution to the prognosis of a patient. A novel DCA device (ATHEROCUT™, Nipro Corporation) has achieved a safer DCA procedure, although its use still requires highly experienced interventionists and engineers. Second, DCA procedures have to be performed during percutaneous coronary intervention (PCI), and we cannot obtain samples from healthy persons or patients without significant stenosis as control samples, unlike autopsy assessment. Third, we cannot see the pathological results of DCA and autopsy simultaneously. For that reason, we cannot exclude artificial effects in
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Figure. Directional coronary atherectomy (DCA) catheter was distributed by Guidant. This device was revised twice in the bare metal stent era. In the bare metal stent era, in-stent stenosis was frequently observed and DCA was used relatively often for resection of this type of lesion. While the coronary artery samples obtained are sometimes used for pathohistology, this device was mainly used as a therapeutic device because the histology of in-stent neointimal formation is relatively homogeneous tissue including smooth muscle cell proliferation. On the other hand, in the drug-eluting stent era, opportunities to use DCA have been significantly reduced by the effects of DES. Even today, some patients exhibit treatment resistance to DES. This report suggests that new generation DCA can be used not only as a therapeutic device, but also for the evaluation of inflammatory responses to DES with in-stent restenosis, which is not possible with optical coherence tomography (OCT).

Disclosures

Conflicts of interest: None.

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