A Novel Optical Coherence Tomography System for Lipid-rich Plaque Detection

Aiko Shimokado1, Takashi Kudo1, Tsuyoshi Nishiguchi1, Akira Taraya1, Bakio Teraguchi1, Makoto Orii1, Yasutosugu Shiono1, Kunihiro Shimamura1, Takashi Tanimoto1, Yamano Takashi1, Yoshide Matsuo1, Yasashi Ino1, Tomoyuki Yamaguchi1, Kumiko Hira1, Atsushi Tanaka1, Takashi Akasaka1
1Wakayama Medical University, Wakayama, Japan
2Kansai University Hospital, Utsunomiya, Japan
3Osaka University Hospital, Osaka, Japan
4National Cardiovascular Center Research Institute, Osaka, Japan
5National Cardiovascular Center Research Institute, Osaka, Japan
6Osaka University Hospital, Osaka, Japan
7Nara Medical University, Ibaragi, Japan
8Kanto Gakuen University, Chiba, Japan
9National Cardiovascular Center Research Institute, Osaka, Japan
10National Cardiovascular Center Research Institute, Osaka, Japan
11National Cardiovascular Center Research Institute, Osaka, Japan
12National Cardiovascular Center Research Institute, Osaka, Japan

Background: Vulnerable coronary artery plaque characterized by large lipid core. Although commercially-available OCT systems use near-infrared light at 1,300 nm wavelength, lipid shows characteristic absorption at 1,700 nm. Therefore, we developed a novel, short wavelength (1,700 nm) infra-red, spectroscopic, spectral-domain optical coherence tomography (SWIR-OCT). The aim of the present study is to evaluate the accuracy of SWIR-OCT for identification of lipid tissue within coronary plaques.

Methods: Twenty-three coronary arteries from 8 cadavers were imaged at physiological pressure with 2.7F SWIR-OCT catheter. When a blood-free image was observed, the SWIR-OCT imaging core was withdrawn at a rate of 20 mm/sec using automatic pullback device. SWIR-OCT images were acquired at 94 frames/s and digitally archived. SWIR-OCT generated gray-scale cross sectional images and color tissue maps of entire plaque by using lipid analysis algorithm. After SWIR-OCT imaging, the arteries were pressure-fixed, sliced by cryostat and stained with Oil Red O, and corresponding histology was collected in matched images. Regions of interest, selected from histology, were 75 lipidic and 64 fibrotic/calcified regions.

Results: SWIR-OCT showed high sensitivity (84%) and specificity (92%) for identifying lipid tissue within coronary plaques. The positive predictive value and negative predictive value were 98% and 48%, respectively.

Conclusions: SWIR-OCT accurately identified lipid tissue in coronary autopsy specimens. This new technique may hold promise for identifying pathological feature of coronary plaques at risk for rupture.

Temporal course of neointimal maturity after implantation of biodegradable polymer sirolimus-eluting stents as assessed by optical coherence tomography

Erson Xhepa1, Tomohisa Tada1, Elena Guerra2, Christian H. Heeger1, Franz-Josef Neumann1, Michael Hande1, Martin W. Bergmann1, Stefan Windecker1, Adnan Kastrati1, Michael Jones1, Robert Byrne1
1Deutsches Herzzentrum, Munich, Germany
2St. George Department of Cardiology, Hamborg, Germany
3Universitäts-Herzzentrum Freiburg - Bad Krozingen, Bad Krozingen, Germany
4Zentrale für Kardiologie, Berlin, Germany
5Universitäts-Herzzentrum Freiburg - Bad Krozingen, Bad Krozingen, Germany
6Universitäts-Herzzentrum Freiburg - Bad Krozingen, Bad Krozingen, Germany
7Städtische Kliniken Neuss, Lukaskrankenhaus GmbH, Neuss, Germany
8Bern University Hospital, Bern, Switzerland
9CVPath Institute Inc., N/A

Background: We previously reported that in patients undergoing follow-up after stenting optical coherence tomography (OCT) gray-scale signal intensity (GSI) analysis can differentiate between stent coverage with mature (smooth muscle cell-rich) versus immature tissue (hypocellular brin-rich) using histopathologic data as gold standard. However the temporal evolution of these changes in the months after stenting remains unknown.

Methods: We studied neointimal maturity as assessed by OCT-deried GSI analysis of tissue overlaying stent struts in 3 separate cohorts of patients undergoing OCT follow-up at 3 months, 6 months and 9 months after coronary stenting with biodegradable polymer sirolimus-eluting stents (ORSIRO, Biotronik, Bülach, Switzerland). Offline analysis of contiguous cross-sections was performed at 1 mm longitudinal intervals within the stented segment. For each cross-section the neointimal region of interest (ROI) above each covered strut was manually delineated and 256-level GSI was measured for every pixel within the ROI. Calibration was done with brightest spot GSI analysis using guide-wire at 3 and 6 months and stent strut at 9 months. Cut-off values for mature vs. immature tissue for each scale were derived from published data.

Results: OCT raw data was available for 8, 24 and 27 lesions at 3 months, 6 months and 9 months respectively. In patients undergoing follow-up at 3 months, 1602 ROIs were analyzed and median GSI scores were 90.7 [95%CI 52.9 – 134.7]; 28.3% of ROIs were categorized as mature. At 6 months, 5315 ROIs were analyzed and median GSI scores were 105.2 [62.0 – 148.4]; 38.2% of ROIs were categorized as mature. At 9 months, 3501 ROIs were analyzed and median GSI scores were 106.4 [63.3-149.5]; 58.8% of ROIs were categorized as mature.

Conclusions: In patients undergoing OCT follow-up after stenting GSI-derived scores of neointimal maturity show progressive change over time. While only a minority of tissue areas overlaying stent struts were characterized as mature at 3 and 6 months, at 9 months stent implantation the majority of covered struts could be classified as mature. Future studies should examine the clinical relevance of differences in tissue maturity over time.

Morphological Characteristics Of Coronary Artery Spasm Sites In Vasospastic Angina: An Optical Coherence Tomography Study

Eun-Seok Shin1, Soo Hee Ann1, Gillian K. Balbir Singh1, Kyung Hun Lim2, Hyuck-Jun Youn1, Seung-Ho Hah1, Ae-Young Her1, Bon-Kwon Koo1, Takashi Akasaka1
1Ulsan University Hospital, Ulsan, Kyoungsangnamdo, 2Ulsan University Hospital, Ulsan, Gyeongbuknam-do

Background: Plaque characteristics at coronary artery spasm sites have not been systematically investigated. The aim of this study is to define the morphological features of coronary artery spasm sites using optical coherence tomography (OCT). C7XR and Dragon Fly catheter, Lightlab Imaging/St. Jude Medical, Westford, Massachusetts, USA in patients with vasospastic angina (VSA).

Methods: Sixty-nine consecutive patients (80 spasm sites) with VSA manifested with acute coronary syndrome who underwent OCT imaging were included in this study. The characteristics of the spasm sites were defined as plaque disruption, plaque erosion (definite, probable, possible) or unclassified by diagnostic criteria of OCT. Definite erosion was defined by concurrence of thrombus and an irregular luminal surface with intact fibrous cap at multiple adjacent OCT frames.

Results: Plaque was seen on OCT in 79 of the 80 spasm sites. Definite erosion was observed at 20 spasm sites (25%). Thrombus without lumen irregularity (probable erosion) was observed at 1 spasm site (1%). Lumen irregularity without thrombus (possible erosion) was observed at 49 spasm sites (61%). Plaque disruption was detected at 3 sites (4%). Spontaneous erosion was seen more frequently in acute myocardial infarction (AMI) and out-of-hospital cardiac arrest (OHCA) patients compared to non-AMI/OHCA patients (50.0% vs. 19.3%, p=0.025).

Conclusions: Our results show that OCT defined plaque erosion with thrombus is a common finding in patients with VSA. This finding suggests the potential benefit and treatment role of antiplatelet therapy in VSA.