CASE REPORT

Illusion or reality? How 3-dimensional optical coherence tomography overcomes the limitations of angiography: OCT-guided percutaneous coronary intervention of left main stem disease involving LAD/LCx bifurcation

Yanılgı mı, gerçek mi? 3-boyutlu optik koherens tomografi anjiyografinin sınırlamalarını aşıyor: OCT kılavuzluğunda LAD/LCx bifurkasyonunu içeren sol ana koroner hastalığına perkütan koroner girişim

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Summary– Angiography is still the workhorse imaging approach for the vast majority of percutaneous coronary revascularization (PCR) cases. However, the limitations of angiographic guidance for coronary procedures have been well established. This case report demonstrates how 3-dimensional optical coherence tomography (3D OCT) can change the treatment strategy, which, had only the angiography results been considered, seemed to be straightforward. A 67-year-old male patient presented with non-ST-elevation myocardial infarction. A coronary angiogram revealed a tight lesion of the proximal left anterior descending artery (LAD). Angiographically, the vessel ostium appeared not to be involved. To clarify the disease border and determine the right stenting strategy, 3D OCT was performed. Measurements revealed heavy disease of the LAD, ranging from the ostium to the left main coronary artery (LMCA). It was decided to proceed with a provisional stenting strategy of the LMCA and the LAD. After postdilatation, the angiography revealed a good result for the LAD, but significant pinching of the ostium of the LCx. The kissing balloon technique was then applied at the LAD/LCx bifurcation. The final OCT examination documented a well-expanded stent without areas of malapposition and an open LCx ostium without significant narrowing. Intracoronary images obtained using OCT add significant information to what is provided by angiography alone, thereby improving the interpretation of angiographic images and the planning of the PCR procedure.

Özet– Anjiyografi, perkütan koroner girişim (PKG) sırasında yaygın olarak kullanılan bir görüntüleme metodudur, fakat lezyonun gerçek boyutunu değerlendirmede sınırlı bilgiler verir. Bu olgu sunumu, anjiyografik görüntüleme sırasında basit olarak değerlendirilen bir lezyonda, 3-boyutlu optik koherens tomografinin (3D OCT) tedavi stratejisini nasıl değiştirdiğini göstermektedir. ST yükselmesiz miyokart enfarktüsü geçiren 67 yaşındaki erkek hastanın koroner anjiyografisinde proksimal sol ön inen arterde (LAD) ciddi darlık tespit edildi, fakat hastalığın ostiyuma kadar uzanmadığı görüldü. Hastalık sınırını net olarak belirlemek ve doğru girişim stratejisini belirlemek için, işlem öncesinde 3 boyutlu optik kohorens tomografisi yapıldı. Ölçümler, ostiyumdan başlayıp sol ana koroner artere (LMCA) kadar uzanan uzun bir LAD lezyonunu ortaya koydu. LMCA ve LAD'yi kapsayan provizyonel stent stratejisi ile ilerlemeye karar verildi. Postdilatasyondan sonra, anjiyografik olarak LAD'de iyi sonuç alınırken, LCx'in ostiyumunda belirgin bir daralma tespit edildi ve LAD/LCx bifürkasyona *kissing balloon* tekniği uygulandı. Nihai OCT işlemi, stentin iyi genişlemiş olduğunu ve LCx ostiyumunun açık olduğunu gösterdi. Optik koherens tomografisi ile elde edilen görüntüler, anjiyografinin tek başına sağladığı bilgilere önemli ölçüde katkıda bulunur ve böylece bize PKG stratejisini doğru bir şekilde planlama fırsatı verir.

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Angiography is still the mainstay imaging approach for the vast majority of percutaneous coronary revascularization (PCR) cases. However, the limitations of angiographic guidance for coronary procedures are well established. This case report demonstrates how 3-dimensional optical coherence tomography (3D OCT) changed what appeared to be a straightforward treatment strategy based on the angiography results.

CASE REPORT

A 67-year-old male patient presented with acute coronary syndrome. An electrocardiogram revealed precordial T-wave inversion, while transthoracic echocardiography demonstrated impaired left ventricular systolic function with an ejection fraction of 48% and apical hypokinesis.

Left main stem disease with a tight lesion of the proximal LAD was detected on a coronary angiogram. The involvement of the ostia of the LAD and the LCx was angiographically not apparent (Fig. 1a, b).

To determine the severity of the LMCA lesion and the ostial involvement of both vessels, 3D OCT was planned (Optis System, Lightlab Imaging, Inc., Abbott Vascular Inc., Santa Clara, CA, USA).

Before advancing the OCT catheter, the tight LAD lesion was pre-dilated with a 2.0x20-mm Mini Trek balloon (Abbott Vascular Inc., Santa Clara, CA, USA) in order to avoid catheter-induced occlusion of the vessel.

Measurements revealed heavy disease of the LAD, beginning at the ostium with a minimum lumen area (MLA) of 0.99 mm^2 and continuing to the LMCA, with a MLA of 5.4 mm^2. The ostium of the LCx demonstrated a moderate plaque burden without significant narrowing (Fig. 2).

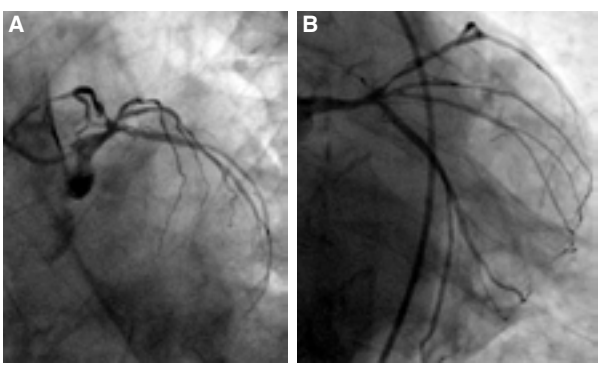

Figure 1. Coronary angiogram. **(A)** Spider view; **(B)** right anterior oblique caudal view.

Abbreviations:

IVUS	*Intravascular ultrasound*
LAD	*Left anterior descending artery*
LCx	*Left circumflex artery*
LMCA	*Left main coronary artery*
MACE	*Major adverse cardiovascular events*
MLA	*Minimum lumen area*
OCT	*Optical coherence tomography*
PCI	*Percutaneous coronary intervention*
PCR	*Percutaneous coronary revascularization*
TLR	*Target lesion revascularization*

It was decided that a provisional stenting strategy of the LMCA and the LAD was appropriate. Stent length and diameter selection were based on the assessment of the least diseased proximal and distal OCT landing zones, indicating a stent length of approximately 50 mm (Fig. 2).

A 4.0x28-mm Xience Prime (Abbott Vascular Inc., Santa Clara, CA, USA) stent was implanted directly, covering the LMCA and the proximal LAD. A second 3.0x18-mm Xience Prime stent was positioned with a small overlap, covering the distal lesion.

Post-dilation was then performed using a 5.0x8-mm balloon for the LMCA and a 3.0x15-mm balloon for the LAD. Angiography demonstrated a good result for the LAD, but revealed a significant pinching of the ostium of the LCx (Fig. 3a). Therefore, the kissing balloon technique was applied at the LAD/LCx bifurcation with a 3.0x15-mm balloon for the LAD stent and a 4.00x15-mm balloon for the LCx stent (Fig. 3b-c).

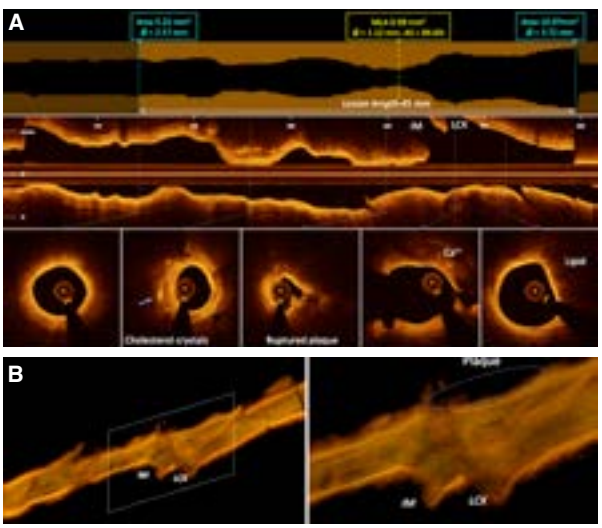

Figure 2. Optical coherence tomography (OCT). **(A)** Left main coronary artery-left anterior descending artery pull-back; **(B)** three-dimensional OCT images of the ostia of the intermediate branch (IM) and the left circumflex artery (LCx).

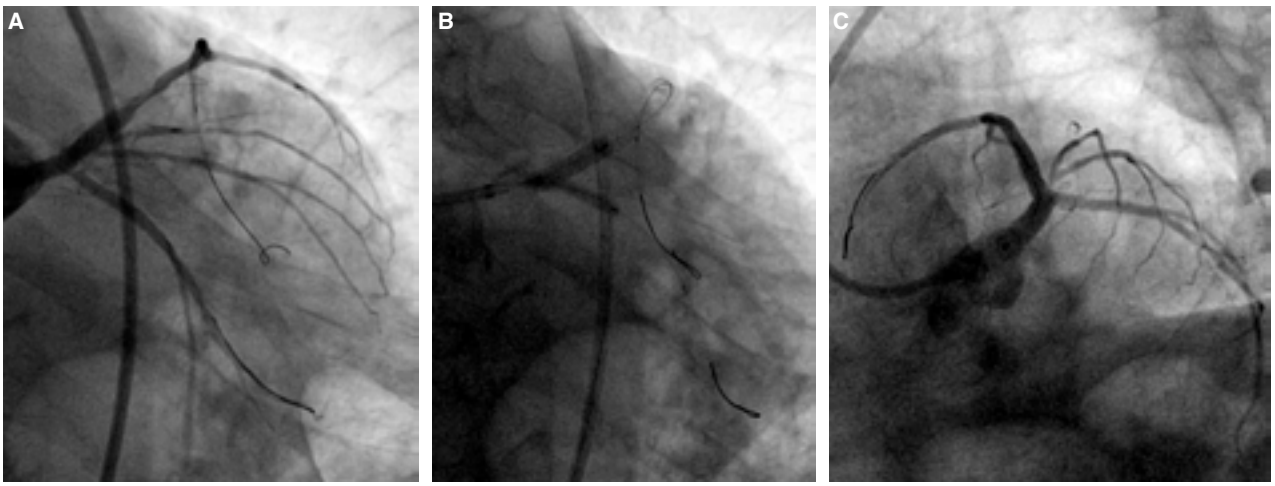

Figure 3. Coronary angiogram. **(A)** Pinching of the left circumflex artery (LCx) ostium after stent implantation into the left main coronary artery/left anterior descending artery (LAD); **(B)** kissing balloon for the LAD and LCx stents; **(C)** result after kissing balloon technique.

The final OCT examination documented a well-expanded stent without areas of malapposition and a LCx ostium without significant narrowing (Fig. 4a, b). The MLA of the LMCA increased to 13.2 mm^2, and the LAD had a MLA of 8.4 mm^2.

Image acquisition using OCT was not associated with any major complication, as no case of significant spasm, dissection, or life-threatening arrhythmia occurred (i.e., requiring pharmacological therapy, revascularization, or cardioversion/defibrillation). Accordingly, no significant differences in postprocedural renal function were found.

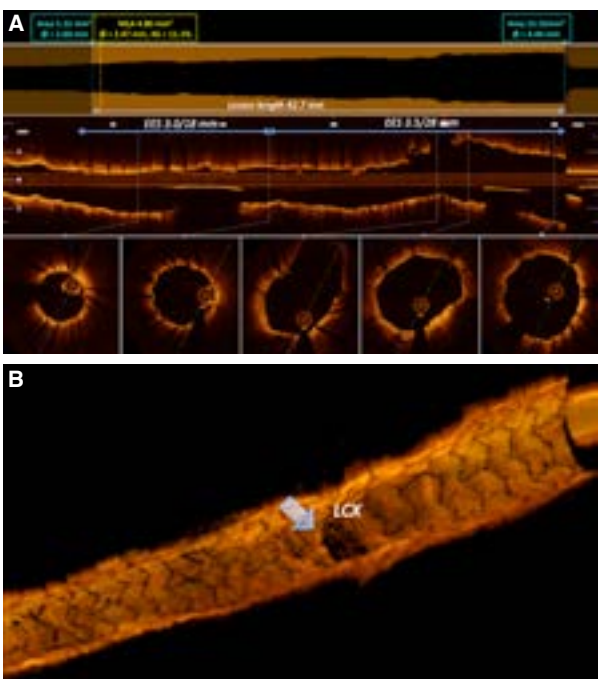

Figure 4. Optical coherence tomography (OCT). **(A)** After stent implantation; EES: Everolimus-eluting stent. **(B)** Three-dimensional OCT image showing the ostium of the left circumflex artery (LCx) after the kissing balloon procedure.

After discharge, the patient was followed as per local practice at 1 to 3 and 6 to 12 months. No major adverse cardiovascular event, including myocardial infarction and target lesion revascularization, was observed.

DISCUSSION

Since the introduction of percutaneous coronary intervention (PCI), the evolution in techniques and devices has dramatically reduced the risk of early complications and has improved long-term results. However, the limitations of angiographic guidance for coronary procedures are well established. Nonetheless, angiography is still the workhorse imaging approach for the vast majority of PCI cases. In the current case, based on the angiographic images, the stent might have been left at the LAD ostium without coverage of the proximal diseased region. Covering a sick vessel ostium is of immense importance, especially if the distal LMCA is involved, as stent deployment into a diseased region is associated with diverse complications, including no-reflow and in-stent restenosis.[1] Intracoronary images obtained using OCT add significant information to what can be provided by angiography alone, thereby improving the understanding gained

from angiographic images and allowing practitioners the opportunity to plan the PCI procedure properly. Some technical issues to be considered regarding OCT use in a LMCA PCI: The main technological disadvantages of OCT were the need to flush the lumen to achieve a blood-free field, which makes adequate assessment of ostial LMCA lesions more difficult. Although intravascular ultrasound (IVUS) may be performed with the catheter disengaged from the artery, OCT in this setting requires the selection and positioning of a guide catheter precisely at the ostium to allow an adequate flush of the lumen during pullback.[2] But in distal LMCA disease, OCT is an adequate alternative imaging method compared with IVUS, and even superior in a number of aspects, particularly distinguishing vulnerable plaques, thrombus formation, coronary dissection, and incomplete stent apposition following implantation.[2] Each technique provides complementary information to images obtained with angiography.

DOCTORS (Does Optical Coherence Tomography Optimize Results of Stenting) was the first, randomized, multicenter study to evaluate the impact of combined angiographic and OCT imaging on PCI optimization.[3] A majority of the patients involved in the study presented with non-ST-elevation myocardial infarction; OCT-guided PCI was associated with higher post-procedure fractional flow reserve than PCI guided by angiography alone.

The ILUMIEN I study demonstrated that a pre-PCI strategy planned using angiography changed in 57% of cases when OCT was also available.[4] Stent length and diameter were the same on average in both randomization groups, although larger and longer stents were expected to be selected with OCT guidance.[4,5] Post-PCI fractional flow reserve values were significantly lower in cases with pre- and post-PCI using the results of OCT, but no longer significantly different after post-PCI stent optimization.

It remains to be investigated whether the use of additional interventions after OCT image acquisition will lead to improved clinical outcomes. A simplified protocol would be very helpful to standardize both angiography-guided and OCT-guided procedural techniques. For interventions to ostial lesions of the LAD or LCx, determination of the lesion extent with intracoronary imaging techniques, such as OCT, seems to be essential, as presented in this case.

Conclusion

OCT facilitates decision-making regarding PCI of ambiguous lesions, especially in cases where ostial disease involvement is not clear angiographically.

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Informed Consent: Written informed consent was obtained from the patient for the publication of the case report and the accompanying images.

Competing interests: There are no competing interests.

Authorship contributions: Aylin Hatice Yamac has performed the PCI and OCT procedures, interpreted the data, has written the manuscript and did the final approval.

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Keywords: Ambiguous coronary lesion; optical coherence tomography; ostial left anterior descending artery lesion.

Anahtar sözcükler: Belirsiz koroner lezyonu; optik koherens tomografi; ostiyal sol ön inen arter lezyonu.