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### Title

The Long and Winding Road of Intravascular Ultrasound Imaging

### Permalink

<https://escholarship.org/uc/item/1sv147kn>

### Journal

Catheterization and Cardiovascular Interventions, 81(3)

### ISSN

1522-1946

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### Publication Date

2013-02-01

### DOI

10.1002/ccd.24816

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Peer reviewed

## **Editorial Comment**

### **The Long and Winding Road of Intravascular Ultrasound Imaging**

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On December 31, I celebrated my 65th birthday. That translates into 40 years of clinical medicine and interventional cardiology. So I ask your indulgence as I reminisce about my association with intravascular ultrasound (IVUS) as a way of putting into perspective the accompanying article by Seung-Jung Park's group from Seoul, Korea.

My journey started about 1982 when I met with Walter Henry, Paul Zalesky, Jim Griffith, Tony DeMaria, and others at a hotel on Bourbon Street during an American Heart Association meeting in New Orleans. Walter asked the question, "What if we could build a miniature ultrasound probe that could safely pass into the coronary arteries? Would that be useful?" Squeezing my brain to picture what this might mean, I responded, "Well, it depends on what we would be able to see. If we could see the size of the artery, the amount and type of plaque, then yes, that would be very helpful... and pretty cool."

We and other groups then spent the next 10 years developing the technology and performing the basic in vitro and clinical studies to demonstrate what an IVUS probe in the coronary arteries could do. The initial studies were mind boggling, with images of human coronary artery disease that could only have been obtained up to that time by low power histology after the patient had died. There were skeptics and ridicule as well, which is expected with any new technology until it is proven. My favorite comment was from Gary Roubin who, at a meeting in Brazil, at the Dante Pazzanese Hospital, called intravascular ultrasound a form of "mental masturbation." I refrained from a confrontation with Gary and just laughed. I might point out now that IVUS has lasted longer than his stent. The technique was used by more and more interventionalists and clinical researchers to identify disease with more accuracy than angiography, to help define the type of tissue that was present which was useful for determining what device to employ, to size the coronary artery, and determine what the effects and mechanisms were of balloon dilation, atherectomy, laser, or stenting.

For me, this work culminated in 1992–1998 when I collaborated with Antonio Colombo in Milan to use IVUS to help us understand how to diminish restenosis. As a side story to that effort, we realized from the IVUS images, that stents were inadequately deployed, despite what the angiograms suggested. This led to the use of larger balloons and higher pressures to optimize stent expansion with a resulting dramatic fall in stent thrombosis that facilitated the widespread use of coronary stents.

Even though many operators just use larger, non-compliant balloons at routine pressures of 16–20 atm and forego the extra time and cost of IVUS guidance, IVUS is still useful as a diagnostic tool when there is some clinical question that the angiogram does not explain. Fractional Flow Reserve (FFR) has stolen some of the luster from IVUS as a diagnostic tool to assess the "tightness" of a lesion as FFR provides more physiologic information, but IVUS is still beneficial when the questions being raised concern the anatomy, stent size, or plaque composition. OCT has improved the resolution of intravascular imaging, but the lack of penetration beyond the surface of the lumen is a significant detriment to this form of imaging.

Initially, there were efforts to prove that IVUS guidance could decrease restenosis. We could show with bare metal stents that the restenosis rate was decreased about 5% with IVUS guidance. The use of drug eluting stents has decreased restenosis much further. IVUS guidance for DES has been shown to be useful in complex lesions or bifurcations, and left main disease, but it is difficult to demonstrate a significant effect in decreasing restenosis. We did not expect that the use of IVUS might enhance survival.

With this as background, the article by Hur and SJ Park's group is especially pleasing. Although it is not a

Conflict of interest: Nothing to report.

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Received 8 January 2013; Revision accepted 9 January 2013

DOI: 10.1002/ccd.24816

Published online 15 February 2013 in Wiley Online Library (wileyonlinelibrary.com).

randomized trial, they followed 8,731 patients between 1998 and 2006 who received coronary stents and found that those people who had IVUS guided stenting had a lower risk of mortality,  $HR = 0.63$ . In the patients who received drug eluting stents, the three-year risk of mortality was significantly lower in patients who had IVUS guided PCI,  $HR = 0.46$ , whereas there was no difference in mortality in patients who received bare metal stents.

This was not a randomized trial and the chance of patient and operator selection bias is high. But it is a large population of nonselected, “real-world” patients that interventional operators have to treat on a daily basis. It is helpful to know that IVUS may assist you to improve your results and raise the chance of success for your patient.

Thirty years later, Intravascular Ultrasound imaging is still pretty cool.