How Should We Perform Rotational Atherectomy to an Angulated Calcified Lesion?

Kenichi Sakakura, MD, Yousuke Taniguchi, MD, Mitsunari Matsumoto, MD, Hiroshi Wada, MD, Shin-ichi Momomura, MD, and Hideo Fujita, MD

Summary
Rotational atherectomy to an angulated calcified lesion is always challenging. The risk of catastrophic complications such as a burr becoming stuck or vessel perforation is greater when the calcified lesion is angulated. We describe the case of an 83-year-old female suffering from unstable angina. Diagnostic coronary angiography revealed an angulated calcified lesion in the proximal segment of the right coronary artery. We performed rotational atherectomy to the lesion, but intentionally did not advance the rotational atherectomy burr beyond the top of the angulation. We controlled the rotational atherectomy burr and stopped it just before the top of the angulation to avoid complications. Following rotational atherectomy, balloon dilatation with a non-compliant balloon was performed, and drug-eluting stents were successfully deployed. In this manuscript, we provide a review of the literature on this topic, and discuss how rotational atherectomy to an angulated calcified lesion should be performed. (Int Heart J 2016; 57: 376-379)

Key words: Angulated lesion, Calcification, Complications

Rotational atherectomy has several unique complications such as burr entrapment or perforation. The risk of such complications is greater in an angulated calcified lesion compared to a straight calcified lesion, therefore, the official product document of rotablator (Boston Scientific, Natick, MA, USA) does not recommend to perform rotational atherectomy to angulated (≥ 45°) lesions. Indeed, there are several reports of burr entrapment or perforation following rotational atherectomy to the angulated lesions.

We present a case with an angulated calcified lesion, which was treated by rotational atherectomy. We ablated only halfway to an angulated calcified lesion intentionally in order to avoid complications. Our method to the angulated calcified lesion appeared to be safer, and may be equally effective as conventional rotational atherectomy to an angulated calcified lesion.

Case Report
An 83-year-old female on chronic hemodialysis was referred to our medical center for percutaneous coronary intervention (PCI). Coronary angiography revealed severe stenosis of the proximal and distal segments of the right coronary artery (RCA) (Figure 1A). The proximal lesion was calcified and angulated (Figure 1B). We believed that rotational atherectomy would be necessary due to calcification, but there was a substantial risk of vessel perforation or burr entrapment because of the angulation. Therefore, we decided to perform rotational atherectomy as far as to halfway to the angulated calcified lesion, and then use a non-compliant balloon following rotational atherectomy.

An 8-Fr AL 0.75 ST SH guide catheter was inserted via the left femoral artery. We advanced a conventional 0.014 inch guide wire with a microcatheter, and then exchanged the conventional guide wire for a rotawire extra support (Boston Scientific, Natick, MA, USA). We advanced the rotational atherectomy burr 1.5 mm (190,000 rpm) to the calcified lesion (Figure 2A), but intentionally did not advance the burr beyond the angle. Following the Rotablator, we advanced the 2.5 mm non-compliant balloon beyond the angle, and then dilated it (Figure 2B). Following balloon dilatation to the middle and distal segments of the RCA, we deployed 4 everolimus-eluting stents (3.5 × 28 mm, 3.0 × 38 mm, 3.0 × 38 mm, and 2.75 × 28 mm) to the diffuse long lesion (from the distal segment of the RCA to the ostium of the RCA) and acquired TIMI-3 grade flow (Figure 3).

Discussion
Rotational atherectomy has several unique complications such as the burr entrapment or vessel perforation, and the risk of these complications is greater in angulated calcified lesions. Such complications are strongly associated with morbidity and mortality, while some complications can be man-
Most operators realize that there is greater risk of complications when using rotational atherectomy in an angulated lesion, however, we have no other alternative but to perform rotational atherectomy if balloon dilatation does not work for these tough lesions. Indeed, rotational atherectomy is more frequently used in off-label than on-label situations, and the risk of complications such as slow flow or periprocedural myocardial infarction tends to be greater in off-label situations than in on-label situations. Therefore, it is of utmost importance to find a safer way for rotational atherectomy to an angulated calcified lesion.

There have been two different strategies regarding how to perform rotational atherectomy; One is the lesion modification strategy using small burrs (burr/artery ratio ≤ 0.7), and the other is the aggressive debulking strategy (burr/artery ratio of > 0.7). As compared to the debulking strategy, the lesion modification strategy has fewer angiographic complications with similar immediate lumen enlargement. Therefore, most current interventional cardiologists prefer the lesion modification strategy for calcified lesions, especially when using drug-eluting stents following rotational atherectomy. However, the mechanism of the lesion modification strategy is not well understood. For example, there has been little clear explanation why small (1.25 mm or 1.5 mm) rotational atherectomy burrs are important for approximately 2.5 mm diameter drug-eluting stents in the calcified lesion. Most likely, it is important to make a crack using a small burr for lesion modification (Figure 4). Severe calcification such as napkin ring calcification (Figure 4A) would not be dilated without a crack. To make a crack using a small rotational atherectomy burr is the principle of lesion modification (Figure 4B and 4C). A balloon would dilate the napkin ring calcification with a crack (Figure 4D and 4E).
This lesion modification hypothesis was developed using a 2-dimensional model.

For the angulated calcified lesion, we expanded the lesion modification hypothesis using a 3-dimensional model (Figure 5). A severe circumferential and angulated calcification would not be dilated without a crack. B and C: To make a crack using a small rotational atherectomy burr is the principle of lesion modification. D and E: A balloon would dilate the napkin ring calcification with a crack. D: We can try balloon dilatation (non-compliant balloon) beyond the angle. E and F: The balloon dilatation would likely cause a continuous crack beyond the angle because the edge of the crack would receive high pressure produced by balloon dilatation.

| Table: Advantages and Disadvantages of Halfway Rotational Atherectomy for a Calcified Angulated Lesion |
|-----------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| **Advantages** | Halfway rotational atherectomy | Conventional rotational atherectomy | Comments |
| Low risk of vessel perforation or burr entrapment during rotational atherectomy | The lesion can be easily dilated with a balloon, if the burr advances beyond the angle. | The manufacturer does not recommend Rotablator for angulated (≥ 45°) lesions (Contraindication). |
| **Disadvantages** | There is no guarantee that the lesion beyond the angle would be dilated with a balloon following halfway rotational atherectomy. | The risk of vessel perforation and burr entrapment is greater, when the angle of the lesion is steeper. | Switch from halfway rotational atherectomy to conventional rotational atherectomy is easy, because there would be no severe complications following halfway rotational atherectomy. |

In conclusion, rotational atherectomy to an angulated calcified lesion is always challenging. Halfway rotational atherectomy, which means that an operator does not advance the rotational atherectomy burr beyond the angle, would be a safer method to avoid fatal complications such as burr entrapment or perforation.
perforation. Although the present case report might provide a novel method for angulated calcified lesions, the validity of halfway rotational atherectomy should be investigated in future clinical studies.

**DISCLOSURES**

Dr. Sakakura received speaking honorarium from Abbott Vascular, Boston Scientific, Medtronic Cardiovascular, and Terumo.

**REFERENCES**