Rotational Atherectomy in Clinical Practice
The Art of Tightrope Walking

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Unlike balloon dilation that results in the displacement of atherosclerotic plaque with multiple intimal tears, rotational atherectomy (RA) is based on the principle of differential cutting that allows for physical removal of inelastic atherosclerotic material while rendering the inner lumen surface smooth. Although plaque reduction by pulverization of atherosclerotic material into <10 \( \mu \)m particles has remained its central paradigm, the conceptual framework has shifted from the original approach of RA as a debulking strategy and, thus, applicable in a broad array of coronary lesions with large plaque burden, to a contemporary selective clinical utilization, with an emphasis mainly on plaque modification prior to stent implantation. This transition in conceptual understanding of the targeted effects of RA has been mirrored by a decreasing tendency in its use, from 20% in the mid 1990s to 1% to 3% according to contemporary reports. Today, RA is used selectively, mainly to disrupt the continuity of the calcium ring within the vessel wall and, thus, facilitate optimal drug-eluting stent (DES) implantation in patients with severely calcified de novo coronary lesions. ROTAXUS (Rotational Atherectomy Prior to Taxus Stent Treatment for Complex Native Coronary Artery Disease), as the only randomized trial to date that tested the strategy of routine lesion preparation with RA followed by DES implantation against stenting without RA, showed a higher rate of procedural success in patients undergoing RA, which, however, did not translate in long-term clinical benefit. These findings coincided with previous nonrandomized studies that had also supported RA as a means of achieving immediate procedural success in calcified coronary lesions, whereas long-term clinical benefit had not been consistently proven. However, the majority of the studies had an inherent limitation of nonstandardized preprocedural lesion assessment, which may have obscured the potential superiority of RA in the most complex lesion subset, considering the fact that inadequate stent deployment is often present in severely calcified coronary lesions, even after high-pressure balloon dilation.

The opinions expressed in this article are not necessarily those of the editors or of the American Heart Association.

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See Article by Sakakura et al

Apart from failing to so far demonstrate long-term reduction in major adverse cardiovascular events, the use of RA in everyday clinical practice has been hampered by the increased risk of periprocedural complications.

In this issue of Circulation: Cardiovascular Interventions, Sakakura et al report on the occurrence of RA-related complications from a nationwide percutaneous coronary intervention (PCI) registry in Japan that included 415,025 patients, of which 3.2% (n=13,495) were treated with RA during 2014 and 2015. After excluding patients with missing data, the study population consisted of 13,335 RA-treated patients. The combined incidence of major complications, defined as in-hospital death, cardiac tamponade, and emergent surgery, was 1.31% (n=175). Compared with the overall registry population, patients undergoing RA facilitated PCI had similar rates of in-hospital death (0.63% versus 0.60%, respectively) and emergent surgery (0.10% versus 0.18%, respectively), while the occurrence of cardiac tamponade was more frequent in patients with RA (0.64% versus 0.13%). The combined rate of major complications was inversely proportional to institutional experience, with the lowest complication rate (1.06%) in high-volume centers (≥25 RA procedures over 2 years). Advanced age, impaired renal function, previous myocardial infarction (MI), multivessel coronary disease, left main disease, emergent PCI, and low institutional volume of RA were independent predictors of major complications.

This study used the hitherto largest sample of RA-treated patients, and it delivered an important clinical message that a widespread practice of RA (3.2% of total PCI, which matches the highest volume RA centers) was feasible and associated with an acceptable rate of major complications, including low in-hospital mortality, albeit with positive effects being directly proportional to the institutional case load.

However, several important issues regarding the everyday clinical practice of RA seem to have remained unaddressed, mainly because of inherent limitations of the retrospective study design.

First, the incidence of periprocedural MI was not reported, which may have obscured potentially negative long-term impact of inadequate RA technique that has been linked to increased myonecrosis. Notwithstanding the notorious ambivalence in defining prognostically relevant degree of isolated peri-PCI cardiac enzyme elevation in RA-treated patients, periprocedural biomarker rise is often coupled with the evidence of angiographic complications, such as coronary spasm or no-reflow, thus likely fulfilling the criteria of a clinically relevant periprocedural MI according to the Third Universal MI definition.
Second, no specific data on the most common RA-related complications, such as slow-flow/no-reflow, dissection, bumm entrapment, and perforation, were provided, even though their frequency in most of the previous trials exceeded the rates of in-hospital death, cardiac tamponade, or emergent surgery. Those relatively common complications seem to be relevant as a quality metric. Not every patient with bumm entrapment needs to be referred to surgical treatment and not every coronary perforation results in cardiac tamponade, but those complications prolong hospitalization and increase the cost of RA-facilitated PCI and, thus, have an impact on the cost-benefit calculation for the use of RA in everyday clinical practice.

Third, it is unclear how the decision to perform RA was made across different PCI centers. Because data regarding the characteristics of lesions treated by RA were not available and no standardized algorithms for RA utilization were described, selection bias could not be ruled out. Furthermore, no description of the use of invasive imaging techniques, such as intravascular ultrasound and optical coherence tomography, was provided. Inconsistent use of intravascular ultrasound or optical coherence tomography may have also contributed to selection bias because invasive imaging could have provided additional information about plaque morphology, including differentiation between superficial and deep position of calcium within the vessel wall, and thus, influence the decision which lesion to treat with RA.5 15

Fourth, even though optimal RA technique has been closely associated with the reduced occurrence of periprocedural complications,1 4 no details regarding the applied RA technique across different PCI centers were presented. These data would have been relevant because the observed inverse relationship between high institution volume and low complication rate12 could have been in part explained by more frequent use of optimal RA technique in centers with larger case load. Importantly, optimal RA technique is tailored to serve as a complication avoidance strategy and mainly consists of the following components:1 4: (1) burt/artery ratio 0.5 to 0.6, while primarily using small burrs (1.25 and 1.50 mm) for plaque modification, with the aim of avoiding angiographic complications, such as no reflow16; (2) lower than traditional ablation speed (140000–150000 rpm), based on the findings that bumm speed is linearly associated with platelet aggregation7; (3) avoidance of decelerations of >5000 rpm for cumulative >5 s because the loss in speed was associated with increased rate of periprocedural MI and restenosis13; (4) bumm advancement using pecking motion in short ablative runs of 15 to 20 s to avoid excessive damage to the vessel wall and minimize the risk of bumm entrapment; and (5) continuous intracoronary flushing with nitroglycerine, heparin, and verapamil or nicorandil or adenosine to avoid spasm and no-reflow.18 19

In summary, similarly to the art of tightrope walking that relies on the skilled interplay of moving forward but not overstepping, performing RA in everyday clinical practice seems to amount to achieving controlled plaque modification while avoiding complications. Thereby, 2 key aspects seem to warrant further research: (1) invasive imaging-based understanding of the mechanisms of plaque modification with RA that may ultimately result in better patient selection and (2) further refinement of technique to minimize the risk of procedural complications.

Disclosures

None.

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