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## Heavily Calcified Coronary Arteries: The Bane of an Interventionalist's Existence

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Heavily calcified coronary arteries are the bane of an interventionalist's existence, and can make stent deployment technically difficult to nearly impossible. Incomplete stent expansion and strut apposition in the setting of extensive calcification increases the risk of subacute stent thrombosis<sup>1</sup> and in-stent restenosis.<sup>2</sup> In the drug-eluting stent era, where adequate stent expansion is perhaps even more critical, a strategy to optimize results in heavily calcified arteries is key. Rotational atherectomy, a niche device that was popularized in the 1990s, uses the concept of differential cutting; destroying areas of inelastic material such as calcified and fibrotic plaques while not disturbing normal elastic tissue.<sup>3</sup> Over the past decade, rotational atherectomy has fallen out of favor primarily due to improved stent delivery systems enabling interventionalists to successfully stent lesions that would previously not be amenable to stenting (including those that are calcified). More recently, however, use of this niche device has been revisited with a focus on its role in modifying calcified lesions prior to deployment of drug-eluting stents.<sup>4</sup> Since heavily calcified lesions are frequently an exclusion criteria in randomized controlled trials, the effectiveness of drug-eluting stents in this setting remains unclear. Several small, retrospective studies have addressed this issue and have reported promising results using the strategy of rotational atherectomy prior to stent placement in heavily calcified coronary arteries.<sup>5–7</sup>

In one study of 150 patients with heavily calcified coronary arteries, 81 patients were pretreated with rotational atherectomy prior to drug-eluting stent placement, and 69 patients were stented without pretreatment.<sup>5</sup> The investigators found that patients who had lesions requiring rotational atherectomy to facilitate deployment of the stent had similar clinical outcomes to patients who had lesions that did not require pretreatment. Similarly, in a separate study of 212 patients with calcified coronary artery lesions, 78 patients underwent pretreatment with a debulking device (including excimer laser, and rotational and directional atherectomy) prior to stenting (36 patients received drug-eluting stents, and 42 patients received bare metal stents), and 134 patients underwent stenting without prior debulking (63 patients received drug-eluting stents, and 71 patients received bare metal stents).<sup>7</sup> While the differences in clinical outcomes at 30 days did not reach statistical significance, patients who underwent drug-eluting stent placement following debulking had the lowest adverse event rate, driven by less target lesion revascularization. Lastly, in a small study of 61 patients with heavily calcified coronary lesions (27 patients underwent rotational atherectomy prior to drug-eluting stent placement, and 34 patient underwent rotational atherectomy prior to bare metal stent placement),<sup>6</sup> there was a significant decrease in late lumen loss at 9 months in patients treated with drug-eluting stents compared to bare metal stents ( $0.11 \pm 0.7$  mm vs.  $1.11 \pm 0.9$  mm,  $P = 0.001$ ). Moreover, the composite outcome of death, myocardial infarction, and target lesion revascularization was 7.4% in the drug-

eluting stent group and 38.2% in the bare metal stent group ( $P = 0.004$ ), suggesting that the combination of rotational atherectomy followed by drug-eluting stent placement may be an optimal strategy for treating heavily calcified lesions.

With these studies as background, in this issue of the *Journal of Interventional Cardiology*, Mezilis and colleagues present their experience in 150 consecutive patients from a single center who underwent rotational atherectomy prior to drug-eluting stent placement for heavily calcified coronary lesions (including focal and diffuse disease, bifurcation and ostial lesions, and chronic total occlusions). The Boston Sci Rotablator system was used, and the 2-burr stepped approach was used in most cases. In total, 171 lesions were pretreated with rotational atherectomy, and stent deployment was successful in 147 patients (98%). None of the patients developed adverse events during the index admission, and clinical follow-up was available in 94% of patients with a mean follow-up of 3 years. The overall major adverse cardiac event rate (including death, myocardial infarction, stroke, target vessel revascularization, and target lesion revascularization) was 11.3%. Of the 150 patients, four patients (2.6%) died, and target lesion revascularization rate was 2%. These results, consistent with other reports,<sup>5-7</sup> suggest that pretreatment with rotational atherectomy prior to drug-eluting stent placement could improve outcomes in patients with heavily calcified lesions by debulking the lesion and facilitating stent apposition to the vessel wall.

As recommended by Mezilis and colleagues, the next logical step is a randomized controlled trial in order to test the hypothesis that rotational atherectomy prior to drug-eluting stent placement in heavily calcified coronary arteries results in better clinical and angiographic outcomes. Critical components of a future randomized trial, which have not been addressed in the present study or other recently published studies due to their retrospective nature,<sup>5-7</sup> should be angiographic follow-up and the use of intravascular ultrasound. Intravascular ultrasound will enable investigators to assess whether the coronary calcification is superficial or deep, and to determine whether the stent is optimally deployed by evaluating apposition of stent struts to the vessel wall, symmetrical expansion of the stent, and minimum intrastent cross-sectional area.<sup>8</sup> With the increased number of elderly and chronic kidney disease patients undergoing percutaneous coronary intervention, and the growing number of patients receiving drug-eluting stents for off-label indications, heavily calcified coronary arteries (the bane of an interventionalist's existence) are here to stay. Properly designed randomized trials are needed to determine optimal treatment strategies in this complex and growing patient population.

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