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Coronary Lithoplasty: Shockwave Lithotripsy for the Coronaries

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Calcified coronaries are always the nightmare of the interventional cardiologist. They cannot be easily dilated by balloon angioplasty and balloons might rupture while high pressure inflation is attempted, leading to coronary dissections and even perforations. Our Urology colleagues have been using extracorporeal shockwaves to fragment renal stone for over a quarter century. Some researchers have used a much lower energy version these shockwaves to treat coronary artery disease which is not amenable to percutaneous coronary intervention or coronary artery bypass grafting with variable success [1]. But these are extracorporeal shockwaves with the shockwaves applied from outside the body using a water cushion. Though they can target specific regions of the heart using echocardiographic guidance, they cannot target specific lesions within the coronaries. Coronary lithoplasty denotes the use of shockwaves delivered within the coronary artery using a specialised balloon catheter.

Basic principle of coronary lithoplasty

Unfocussed acoustic pulses are transmitted circumferentially from transducers located inside a balloon catheter which is positioned inside the calcific coronary lesion. Lithotripsy waves travel outside the balloon and disrupt both superficial and deep calcium within the vessel wall. The action of the shockwaves is more on hard tissue than on soft tissue so that damage to normal vessel wall tissue is minimal. Typically, the balloon is inflated to a low pressure of about 4 atmospheres while the shockwaves are delivered. This improves the compliance of the vessel wall by producing fractures in the calcium along the circumference of the vessel. Shockwave delivery is followed by inflation of the balloon to nominal pressures and later high-pressure inflation to prepare the vessel for coronary stent implantation. The lithoplasty balloon can be delivered over a conventional coronary guidewire.

Clinical studies on coronary lithoplasty

DISRUPT CAD trial used Shockwave Coronary Rx Lithoplasty System (Shockwave Medical, Fremont, California) to deliver localised lithotripsy enhanced disruption of calcified coronary lesions. A s ub study using Optical Coherence Tomography (OCT) evaluated 31 patients with severely calcified coronary lesions [2]. Fracture of calcium within the plaque was noted in 43% of cases, of which circumferential multiple fractures were noted in more than 25%. More fractures occurred in most severely calcified lesions. Mean gain of vessel lumen after lithoplasty alone was 2.1 sq mm, which increased further after stent implantation to achieve a minimal stent area of 5.94 ± 1.98 sq mm. Though deep dissections occurred in 13% after initial balloon angioplasty, they were successfully treated after stent implantation so that there was no acute vessel closure, slow flow, no reflow or perforation. An accompanying editorial by Patrick W. Serruys et al [3] highlighted that final stent expansion was similar among all tertiles of calcification, indicating more efficacy lithoplasty with increasing severity of calcification. They noted that this report is pertinent because it is the first experience with a lithoplasty device to tackle the unmet need in the management of severely calcific coronary lesions.

Stent under expansion due to heavily calcified plaque has been successfully treated with coronary lithoplasty [4]. Shockwave lithoplasty was used to disrupt the calcium surrounding the stent, allowing correct stent expansion as documented by angiography and intravascular ultrasound. Similar experience as a novel treatment for stent under expansion has been reported by Tovar Forero MN et al as well [5].

Though coronary lithoplasty was meant to improve on the disadvantages of rotatational atherectomy, investigators have combined the two together to treat severely calcified in-stent neoatherosclerosis [6]. Rotational atherectomy tends to produce more lesion clearance along the course of the guidewire (guidewire bias) which can cause crater and tunnel formation in tortuous or eccentric lesions leading to perforation or stent malapposition. On the other hand, lithoplasty produces circumferential clearance.

Non-coronary applications of lithoplasty

The Disrupt BTK study has shown that calcified stenoses in infrapopliteal arteries can be safely treated with intravascular lithotripsy [7]. Lithoplasty of iliac artery has been used to facilitate transcatheter aortic valve implantation (TAVI) by transfemoral route in patients with poor vascular access due to calcific stenosis [8,9].

Conclusion

Shockwave lithoplasty is a promising new tool in the armamentarium of the interventionalist to deal with heavily calcific hitherto undilatable lesions. Only future large-scale outocme trials will tells its real place in the cathlab.

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