



INTRAVASCULAR LITHOTRIPSY FOR SEVERE STENT UNDEREXPANSION

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ABSTRACT – Management of heavily calcified lesions during percutaneous coronary intervention (PCI) is often associated with a high incidence of complications and long-term adverse outcomes as the suboptimal coronary stent expansion due to calcified lesion is one of the strongest predictors of adverse outcomes. Shockwave intravascular lithotripsy (S-IVL) is a new technique used in the optimal debulking and preparation of severely calcified coronary artery stenoses, but there is few data on its efficacy in acute or postponed optimization of underexpanded stents. We report a case of a 66-year-old male patient with severe underlying calcification of LAD and a marked stent underexpansion after PCI of chronic total occlusion (CTO) due to a lack of adequate predilatation and postdilatation, where S-IVL was applied, resulting in excellent stent expansion. S-IVL could be considered for treating acute and late stent underexpansion caused by severe underlying calcification.

Key words: *Calcified coronary lesions; complication; coronary artery disease; intravascular lithotripsy; percutaneous coronary intervention; stent underexpansion*

Case report

We report a case of a stent under-expansion due to heavily calcified plaque treated with S-IVL. A 65-year-old male patient with diabetes, hypertension, paroxysmal atrial fibrillation, dyslipidaemia and a history of coronary artery disease underwent coronary angiography after regular check-up in a cardiology office after reporting severe dyspnoea and exhaustion in everyday activities. The patient had a primary percutaneous coronary intervention (PCI) of the left anterior

descending artery in an acute coronary event back in 2013, followed with a stent implantation (drug eluting stent - DES (3.0x16 mm)) and had a mildly reduced ejection fraction of the left ventricle (EFLV) of 45%.

The patient did not have any ambulatory controls since and a recent coronary angiography revealed a chronic total occlusion (CTO) of LAD in the earlier implanted stent (Figure 1). Echocardiography showed a severely reduced EFLV of 25-30% with akinesia of the apical portion, but with viable basal and mid-portion of the anteroseptal wall of the left ventricle.

We decided to proceed to PCI of the CTO of LAD. A 7 French right femoral vascular access was obtained and antegrade wire escalation technique (AWE) was performed using an EBU guide and with support of a microcatheter (Finecross), finally succeeding to

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Figure 1 Chronic total occlusion of the left anterior descending artery

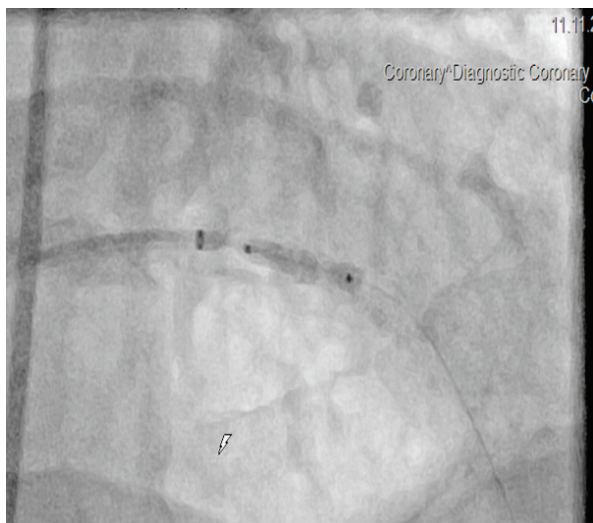


Figure 4 Intravascular lithotripsy balloon in underexpanded stent in LAD



Figure 2 Inadequate expansion of dilatation balloon

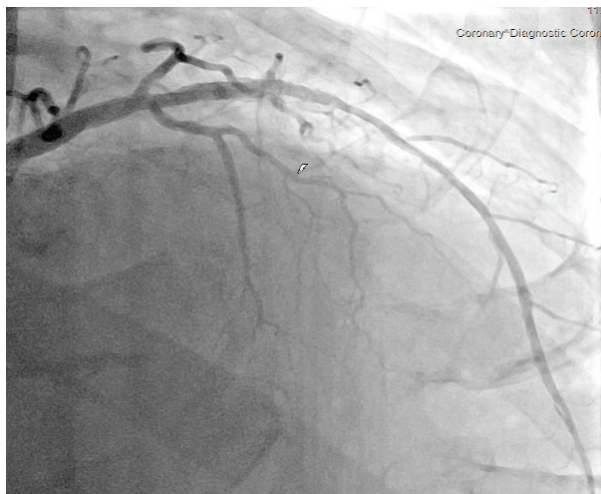


Figure 5 Optimal stent expansion and good angiographic result of the LAD after S-IVL and final post-dilatation

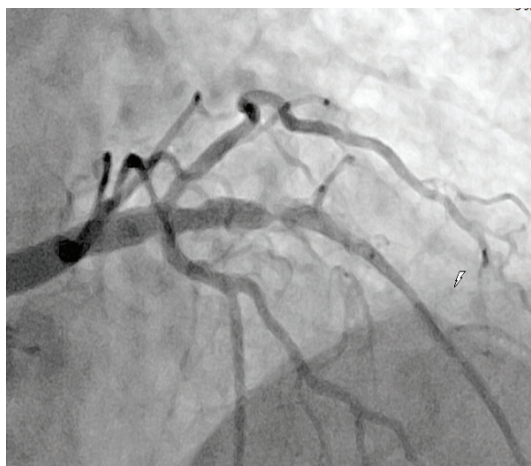


Figure 3 Severely underexpanded stent, final result of PCI of CTO LAD in first procedure

achieve puncture of the proximal cap with Confianza Pro 12 and place a de-escalation floppy wire in the distal true lumen. Multiple predilatations using support of the guide extension (Guidezilla) with semi-compliant (SC) and non-compliant (NC) balloons were obtained (1.5 mm to 2.0x15 mm), but adequate predilatation was not achieved due to repetitive balloon ruptures (Figure 2). A stent implantation (DES 2.75x24 mm at 20 ATM) was performed in hope of adequate postdilatation and preserving distal flow, now compromised due to multiple subintimal wire positions and multiple predilatations, but attempts of adequate post-dilatation were uneventful (Figure 3). The patient was

discharged in a good clinical state with rivaroxaban 20 mg+ ticagrelor 2x90 mg + acetylsalicylic acid 100 mg.

Shockwave lithoplasty balloon (Shockwave 2.5x12 mm with 60 pulses at low-pressure inflation of 4-6 atm) was used in the next procedure scheduled in a 10 -day time-interval after the stent implantation to disrupt calcium deposits around the stent, thereby allowing a correct stent expansion (Figure 4). The final balloon postdilatation with NC balloon (Accuforce 3.0x15 mm) was done with an excellent angiographic result (Figure 5).

Discussion

In this case, we had a CTO of the LAD in an earlier implanted stent, which was successfully recanalised, but with a marked failure to adequately postdilate lesion due to heavily calcifications and repetitive balloon ruptures. Heavily calcified coronary lesions still represent a challenge for percutaneous coronary intervention, given the difficulty to dilate the stenosis and therefore to obtain the correct delivery and implantation of stents.

Several devices have been shown to be useful for the treatment of heavily calcified coronary lesions, including atherectomy, cutting and scoring balloons, noncompliant balloons and very high-pressure non-compliant balloons (OPN). In our case, repetitive NC balloon dilatations failed to achieve adequate lesion preparation, and given the concerns about the safety of the rotational atherectomy (the risk of no reflow, strut embolization, vessel dissections, burr entrapment or stent wrapping), the stated was not performed.¹ All of the mentioned devices and methods are generally less effective or even contraindicated, when used to dilate the lesion once the stent has already been implanted.

Suboptimal stent expansion is in turn associated with poor clinical outcomes in terms of a high rate of major adverse cardiac events. Stent thrombosis and shockwave intravascular lithotripsy technology seems particularly promising to treat calcified lesions for its safety and effectiveness.²

Clinical registry and case series have recently been published, showing the effectiveness and safety of S-IVL to improve refractory stent under-expansion, but with no controlled study published to this date. The use of S-IVL in this context is currently off-label and rare, especially in an acute setting as a bailout method, given the damage it may cause to the polymer or scaffold

of the device^{3,4,5}. A drawback of S-IVL procedure is that the stenosis has to be crossable, and in case of lesion uncrossability, rotational or orbital atherectomy or excimer laser angioplasty still remain the only option, as it was anecdotally described in literature, regardless of all the risk these methods impose⁶.

This case illustrates the efficacy of IVL in the post-hoc stent optimization, and more data on optimal timing of post-hoc IVL to achieve optimal stent expansion are needed, having in mind that it could be a promising and simple solution in that niche of patients, although we should focus on the importance of the optimal lesion preparation before stenting.

Conclusion

Coronary intravascular lithotripsy (S-IVL) has been postulated as a new option for the treatment of non-dilatatable calcified lesions and as such, recognized and confirmed in everyday practice. However, options for patients with the resistant stent under-expansion are limited. Our case demonstrates that S-IVL may be a promising tool for the treatment of under-expanded coronary stents due to short learning curve and easiness to use with good clinical outcomes and safety profile.

References

1. McQuillan M, Jackson Matthew W. P., Brilakis S.E. Uncrossable and undilatatable lesions—A practical approach to optimizing outcomes in PCI. *Catheterization and Cardiovascular Interventions*. 26 May 2020; DOI: <https://doi.org/10.1002/ccd.29001>
2. Yeoh J, Cottens D, Cosgrove C, Mallek K, Strange J, Anderson R, et al. Management of stent underexpansion using intravascular lithotripsy—Defining the utility of a novel device. *Catheter Cardiovasc Interv*. 2020;1–8.
3. Tumminello G, Cavallino C, Demarchi A, Rametta F. Bailout unexpanded stent implantation in acute left main dissection treated with intra coronary lithotripsy: A case report. *Eur Heart J Case Rep*. 2019;3:1–5.
4. Wańha W, Tomaniak M, Wańczura P et al. Intravascular Lithotripsy for the Treatment of Stent Underexpansion: The Multicenter IVL-DRAGON Registry. *JACC Journals* › *JACC* › Archives › **March 2022**, Vol. 79 No. 9_Supplement. Doi: 10.3390/jcm11071779
5. Ali ZA, Nef H, Escaned J. Safety and effectiveness of coronary intravascular lithotripsy for treatment of severely calcified coronary stenoses: the disrupt CAD II study. *Circ Cardiovasc Interv*. 2019;12(10):e008434
6. Daoyuan Si, Guohui Liu, Yaliang Tong, Yuquan He. Rotational atherectomy ablation for an unexpandable stent under the guide of IVUS. *Medicine (Baltimore)*. 2018 Feb; 97(7): e9978. doi: 10.1097/MD.0000000000009978

Sažetak

INTRAVASKULARNA LITOTRIPSIIJA KOD KRITIČNO NEEKSPANDIRANOG STENTA

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Liječenje jako kalcificiranih lezija tijekom perkutane koronarne intervencije (PCI) često je povezano s visokom učestalošću komplikacija i dugoročnih štetnih ishoda jer je suboptimalna ekspanzija koronarnog stenta zbog kalcificirane lezije jedan od najjačih prediktora štetnih ishoda. Intravaskularna litotripsija udarnim valom (S-IVL) je nova tehnika koja se koristi u optimalnoj pripremi teško kalcificiranih stenoza koronarnih arterija, ali postoji malo podataka o njezinoj učinkovitosti u akutnoj ili odgođenoj optimizaciji nedovoljno ekspandiranih stentova. Izvještavamo o 66-godišnjem muškarcu s teško kalcificiranom LAD i izraženom nedovoljnom ekspanzijom stenta nakon rekanalizacije kronične totalne okluzije zbog nedostatka adekvatne predilatacije i postdilatacije, gdje je primijenjen IVL, što je rezultiralo izvrsnom ekspanzijom stenta. S-IVL bi se mogao razmotriti za liječenje akutne i kasne nedovoljne ekspanzije stenta uslijed jako kalcificiranih lezija.

Ključne riječi: Kalcificirane koronarne lezije; komplikacija; koronarna bolest; intravaskularna litotripsija; perkutana koronarna intervencija; nedovoljna ekspanzija stenta