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Case Report

Intravascular lithotripsy (IVL) guided stenting in a calcified critical carotid artery stenosis

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ABSTRACT

Intravascular lithotripsy (IVL) use in carotid artery stenting helps in debulking calcium. Vascular calcium remains a major predictor of failure of interventional procedure. There is fear of hemodynamic worsening and distal embolization with aggressive predilatation which can be prevented by use of IVL. Although it is an off-label use, we hereby report the first case of IVL use in carotid artery from India.

1. Introduction

Atherosclerotic stenosis of the internal carotid artery accounts for 10% of all ischemic strokes.[1] Vascular calcium remains a major predictor of failure of interventional procedure.[2] Intravascular lithotripsy helps in selectively breaking the vascular calcium with minimal effect on the surrounding tissue.[3] IVL was first studied in the lower limb vessels followed by coronary arteries. So far, the use of IVL in carotid arteries is minimal and there is no dedicated balloon for use in carotids. The first reported case of carotid IVL in 2018 utilized a 4 × 15mm Coronary IVL balloon.[4] Subsequently there was a case report using a 4 × 40mm peripheral balloon for carotid IVL.[5] Largest series of carotid IVL – 21 cases from 8 centres across USA/Europe.[6] We hereby report the first case of IVL guided carotid intervention in India (see Table 1).

Aggressive predilatation which is ideally required for calcium debulking results in hemodynamic instability owing to baroreceptor stimulation. Inadequate debulking my result in suboptimal stent tracking and stent expansion. Therefore, calcific stenosis of the carotid artery poses a great challenge for interventional management.

2. Case presentation

A 75-year-old gentleman presented with history of 3 episodes of ischemic strokes over the past one year. All strokes involved the right middle cerebral artery (MCA) territory. He was a hypertensive and had undergone a coronary artery bypass graft surgery (CABG) 8 years ago. His last stroke was 1 month prior to presentation despite being on triple antithrombotic therapy including aspirin, clopidogrel and apixaban. Upon evaluation with CT angiogram, he was found to have a critical stenosis of the right internal carotid artery with a 180% arc of calcium causing eccentric stenosis (figure-1A). In view of the comorbidities and recent history of stroke, he was considered high risk for surgery and also the patient opted for a percutaneous intervention. Use of IVL was felt ideal to address the calcium.

Patient was taken up for procedure after adequate hydration and cessation of antihypertensive medication for 24 hours. A selective right carotid angiogram confirmed the critical stenosis of right internal carotid artery (Fig. 2A). A 0.014″ Filterwire EZ 3.5–5.5mm embolic protection device could not be tracked past the lesion. It was initially crossed using a 0.014” Sion blue coronary wire followed by predilatation with a 2 × 12mm coronary balloon. Subsequently the embolic protection device was placed distal to the lesion. 3 cycles of IVL pulses were delivered using a 4 × 12mm Shockwave balloon inflated at 4atm. Subsequent to the IVL pulse cycle, the balloon was inflated to a nominal pressure of 6atm and

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Abbreviations

IVL	Intravascular lithotripsy
MCA	Middle cerebral artery
CABG	Coronary artery bypass graft

held for 10 seconds (Fig. 2B). There was transient hypotension which improved with fluids and inotropes. A 8-6x40mm X-act self-expanding Nitinol stent (X-ACT, Abbott vascular) was deployed across the lesion. There was minimal residual stenosis and hence not post-dilated (Figures- 1B, 2D). The inotropes were tapered and stopped overnight and subsequent hospital stay was uneventful.

Table 1
The available case reports/case series on use of IVL in carotid interventions.

Year of publication	Number of cases	Countrys	Balloon used	Reference
2018	1	Italy	4 × 15mm Coronary	[4]
2020	1	Poland	4 × 40mm Peripheral	[5]
2020	2	Italy	4 × 12mm Coronary	[11]
2020	2	USA	5 × 60mm Peripheral	[12]
2021	21	Italy/USA	12mm Coronary 40–60mm Peripheral	[6]

Fig. 1. CT angiogram. A: Pre-procedure showing significant vessel wall calcium. B: Post procedure well expanded stent.

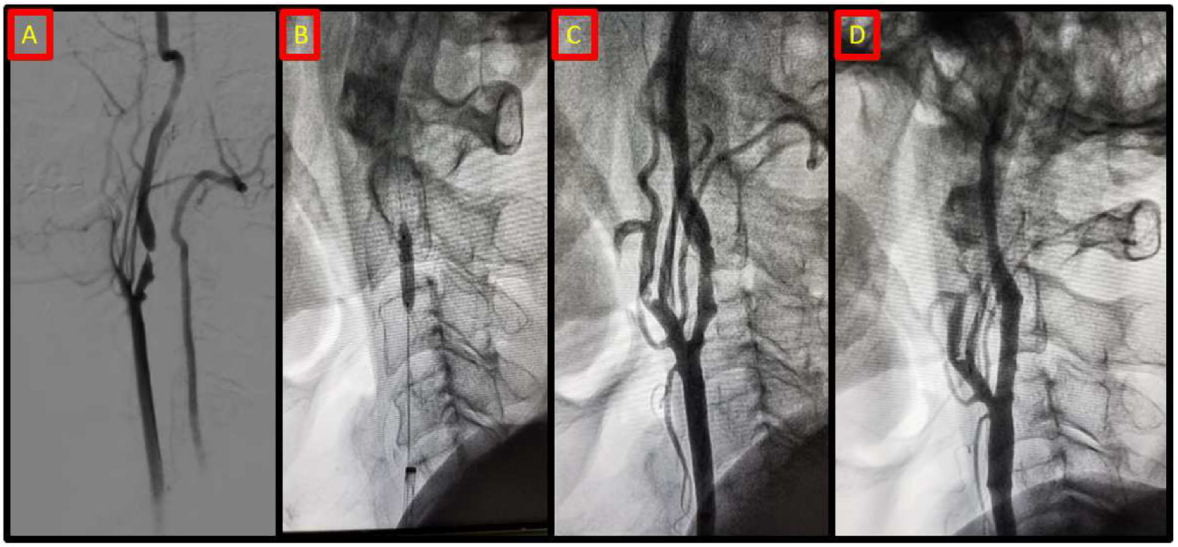

Fig. 2. A: Digital subtraction angiogram showing critical right ICA stenosis, B: 4 × 12mm Shockwave IVL balloon dilattion, C: Post IVL angiogram, D: Post stenting angiogram.

3. Discussion

Although there had been a significant progress in the field of carotid artery revascularization, the greatest challenge remains vessel calcification. The calcification results in inadequate stent expansion causing significant residual stenosis which remains the strongest predictor of future restenosis.[7] Various calcium debulking techniques useful in coronary interventions have been used to tackle the calcification in the carotid artery like scoring balloon,[8] orbital atherectomy[9] and shockwave IVL.[4–6] Aggressive manipulations and use of debulking hardware may result in increased risk of periprocedural ischemic stroke despite the use of embolic protection devices.[10] It is therefore important to have a tool which is simple to use and poses minimum risk for plaque embolization.

Shockwave IVL converts electrical energy into pulses of sonic waves which exert outward compressive force over the vessel calcification thereby cracking it. This causes numerous microfractures over the calcified plaque and thereby better stent expansion without causing any excess distal embolization of the calcium. IVL was initially approved for use in lower limb angioplasty followed by coronary interventions.[3] Its use in carotid artery is off-label. The largest case series of use of IVL in carotid artery stenting comprises of 21 patients, 19 of whom are de novo stenosis and 2 had restenosis. All patients underwent successful angioplasty (residual stenosis <30%) with no singicant adverse events. One patient had a stroke on day 17 but the MRI showed ischemic lesions in bilateral hemispheres suggestive of an arch manipulation induced embolization rather than IVL balloon induced infarct.[6] Two major advantages of IVL are targeted disruption of the vessel wall calcium without damage to surrounding tissue, and also there is no release of embolic material distally. Thus, by safely tackling the calcification, IVL is a very useful tool in performing complex carotid plaque intervention. As of now, use of IVL in carotid artery stenting remains off-label and there are no dedicated balloon sizes for use in carotid artery. Further prospective study data will help establishing the safety and efficacy of IVL in carotid artery stenting.

4. Limitations

A major limitation remains lack of dedicated balloon for carotid artery. The coronary IVL balloon is designed at a standard length of 12mm which is too short in carotid artery and up to a maximum diameter of 4mm which is often not enough for adequate debulking of calcium. The peripheral IVL balloon on the other hand, is available at a larger diameter but the available lengths are 40–60mm which is too long for use in carotid artery. Coronary IVL results in “shocktopics” in 40% cases, causing significant hemodynamic alterations.[3] Similar effects of IVL energy on carotid bulb may result in fatal hemodynamic depression, however, no such effects are reported so far.

5. Conclusion

IVL is a safe choice for debulking calcium in carotid arteries. There is very limited data regarding the use of IVL in carotid artery. To the best of our knowledge, this is the first case of IVL use in carotid artery in India. Although cost remains a major challenge, the ease of use and its safety seems encouraging and warrants further research.

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Declaration of competing interest

None to declare.

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