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Cardiac Shock Wave Therapy (CSWT- PCI) in Heavily Calcified Coronary Artery Disease

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Abstract

Introduction: Dense coronary artery calcification is still a problem. Current options available include coronary atherectomy or cutting balloons of various styles. However, none of them confers promising results. These treatments are either in-effective or complex, with much higher rates of morbidity. A novel treatment option-Cardiac Shock Wave Therapy has been developed and shows very promising results.

Case Report: We report here a case of patient with complex and heavily calcified coronary artery disease. A 71 years gentleman with known case of diabetes mellitus and hypertension presented with chest pain and was diagnosed as NSTEMI in June 2018. His coronary angiogram revealed short left main stem. Left anterior descending was severely atherosclerotic and ecstatic with long proximal aneurysmal segment without any flow limiting stenosis. Left circumflex shows severely diffuse atheroma. Small early OM1 branch with 90% discrete stenosis. Right coronary artery was large, dominant vessel with severe diffuse calcification. Ostial 90% stenosis followed by large aneurysmal segment. Post aneurysm 80% proximal stenosis. Further 90% mid vessel stenosis. Diffuse distal disease. In view of complex and heavily calcified coronaries he was turned down for PCI by interventional cardiologist and was also not considered for CABG as there was a real risk of graft failure because of competitive flow in native coronaries. He was treated with optimal medical therapy. He represented with recurrent angina despite been on optimal antianginal medications. We did perform cardiac shock wave therapy (CSWT- PCI) Pre- dilatation followed by deployment of drug eluting stent in RCA with excellent result.

Conclusion: In conclusion, cardiac shock wave therapy has now becoming the preferred way and is a new non-invasive therapy for densely calcified coronary artery lesion which usually is not amenable for stenting who suffers from myocardial infarction who had no or little chance of revascularisation. Promising result noted in DISRUPT-I and DISRUPT- II trial.

Keywords: Coronary artery; Cardiac shock wave therapy; Myocardial perfusion; Hypertension; Coronaries anatomy

Abbreviations: NSTEMI: Non-ST Elevation Myocardial Infarction; LAD: Left Anterior Descending artery; LCx: Left Circumflex; RCA: Right coronary artery; CABG: Coronary Artery By Grafting; LVD: Left Ventricular Dysfunction; PCI: Percutaneous Coronary Intervention; CSWT: Cardiac Shock

Wave Therapy; DES: Drug Eluting Stent; CAD: Coronary Artery Disease; PCI: Percutaneous Coronary Intervention; OMT: Optimal Medical Therapy; RFA: Refractory Angina; EECP: External Counter-Pulsation; SCS: Spinal Cord Stimulation; CCS: Canadian Cardiovascular Society; OM1: Obtuse Marginal 1; LAO: Left Anterior Oblique View; RAO: Right Anterior Oblique view; LVEF: Left Ventricular Ejection Function.

Introduction

Coronary artery disease (CAD) is being recognized as a major cause of adult mortality globally. Guidelines on the management of stable CAD [1] includes, medical treatment, percutaneous coronary intervention (PCI), and coronary artery bypass grafting (CABG) are the main therapeutic options. In many cases, stable coronary artery disease (CAD) becomes too diffuse and extensive to be treated by traditional revascularization methods. A sizeable number of patients suffer from disabling angina having undergone invasive therapy and optimal medical therapy (OMT), such condition is termed as refractory angina (RFA) [2]. Pharmacological agents such as ranolazine [3] and ivabradine [4] have been suggested for patients with refractory angina (RFA). That said, studies show up to 14% of patients may present with RFA despite of optimal medical therapy, markedly affecting their quality of life [5,6]. Pathophysiological mechanism for RFA is certainly the reduced myocardial perfusion.

Some of the treatment modalities that have been tried to enhance myocardial perfusion and minimize symptoms in patients with RFA include enhanced external counter-pulsation (EECP) [7] and spinal cord stimulation (SCS) [8], other sophisticated modalities such as trans myocardial laser revascularization [9], myocardial or intracoronary application of proteins [10] or genetic vectors encoding proteins with angiogenesis potential [11], and stem cell-based therapies [12]. Thus far, only EECP treatment has been approved and recommended for the management of class III -IV refractory angina by Canadian Cardiovascular Society (CCS) [1,13]. However, the recent studies were inconclusive and found no or small differences between test and control groups with respect to change in angina or exercise duration for patient underwent EECP [14]. Furthermore, other therapies both are invasive, expensive, and have not shown any proven clinical benefit.

Case Report

We report here a case of patient with complex and heavily calcified coronary artery disease. A 71 years gentleman with known case of diabetes mellitus and hypertension, presented with chest pain and was diagnosed as NSTEMI in June 2018. His coronary angiogram done via right radial approach revealed short left main stem (Figure 1). Left anterior descending was severely atherosclerotic and ecstatic with long proximal aneurysmal segment without any flow limiting stenosis (Figures 1 & 2). Left circumflex shows severely diffuse atheroma. Small early OM1 branch with 90% discrete stenosis (Figures 1 & 2). Right coronary artery was large, dominant vessel with severe diffuse calcification. Ostial 90% stenosis followed by large aneurysmal segment. Post aneurysm 80% proximal stenosis. Further 90% mid vessel stenosis (Figure 3). Diffuse distal disease.

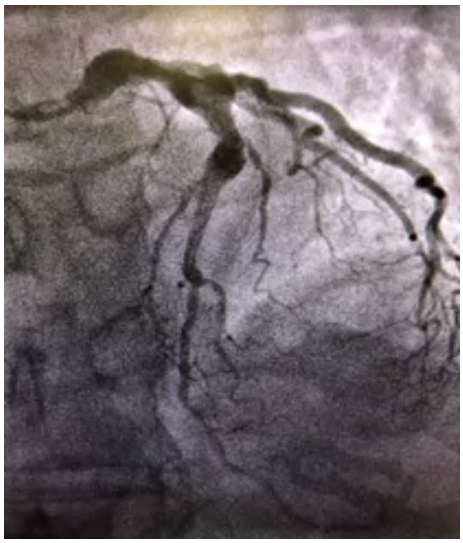


Figure 1: Short left main stem. Left anterior descending was severely atherosclerotic and ecstatic with long proximal aneurysmal segment without any flow limiting stenosis.

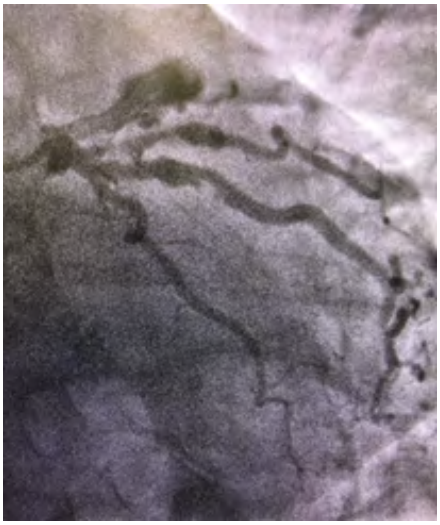
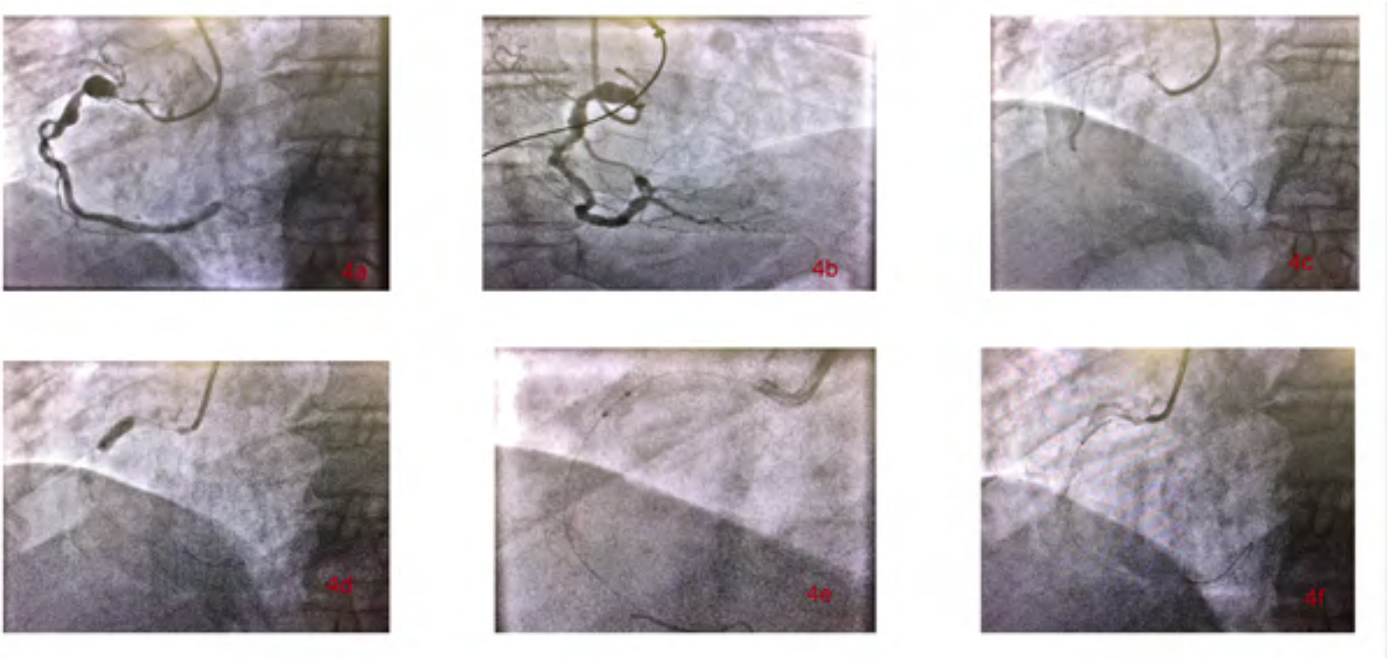


Figure 2: Left circumflex shows severely diffuse atheroma. Small early OM1 branch with 90% discrete stenosis.

Figure 3: Right coronary artery was large, dominant vessel with severe diffuse calcification. Ostial 90% stenosis followed by large aneurysmal segment. Post aneurysm 80% proximal stenosis. Further 90% mid vessel stenosis.

Diffuse distal disease In view of complex and heavily calcified coronaries anatomy, patient was turned down for PCI by interventional cardiologist because of aneurysmal segment and severe calcification.in RCA. Case was discussed at Joint Cardiology/Cardiothoracic meeting. Patient was deemed unsuitable for CABG in view of no flow limiting disease in left anterior descending and only minor disease in left circumflex artery, as there was real risk of graft failure due to competitive flow from native coronaries. Plan was for medical management in first instance, and if symptomatic, then consider Rotablator-PCI to right coronary artery.

Patient was seen in outpatient clinic again in Oct 2018, for exertional symptoms. He was diagnosed as refractory angina. Shock wave therapy had recently been introduced at our centre. His case was further discussion at joint cardiology / cardiothoracic meeting was for Shock wave therapy, PCI to right coronary artery. Mutual consensus was for shock wave therapy percutaneous coronary intervention. We did perform cardiac shock wave therapy (CSWT- PCI) Pre-dilatation followed by deployment of drug eluting stent in RCA with excellent result (Figures 4-6).



Figures 4(a-f): a-LAO view showing severely diseased RCA, pre-PCI; b-showing RCA in RAO view, pre-PCI; c to f- showing RCA with JR 4 Guide Cath and sequential pre-dilatation 2.0x 15 mm balloon.

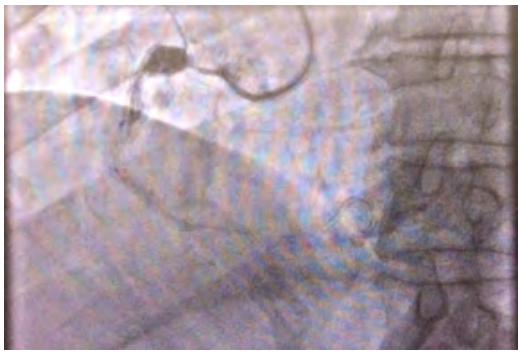


Figure 5a: Shock wave therapy balloon.

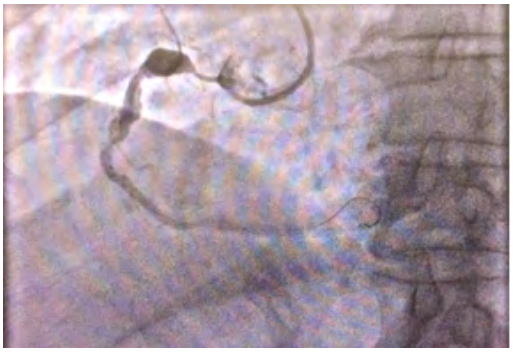


Figure 5b: Shock wave therapy balloon.

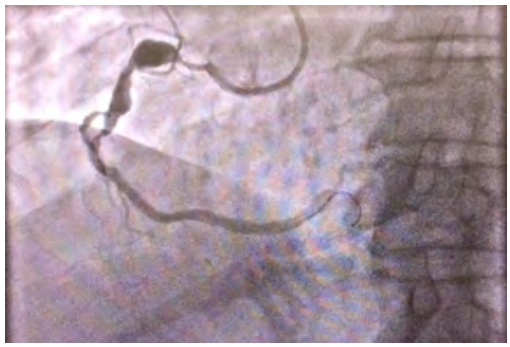


Figure 5c: Shock wave therapy balloon.

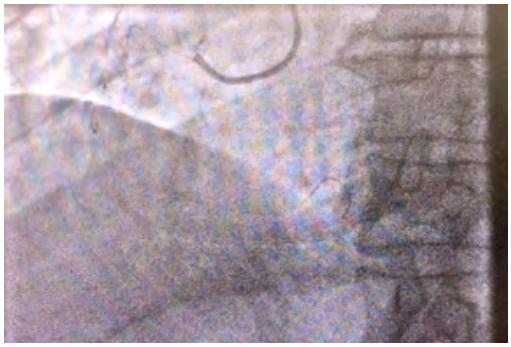


Figure 5d: Shock wave therapy balloon.

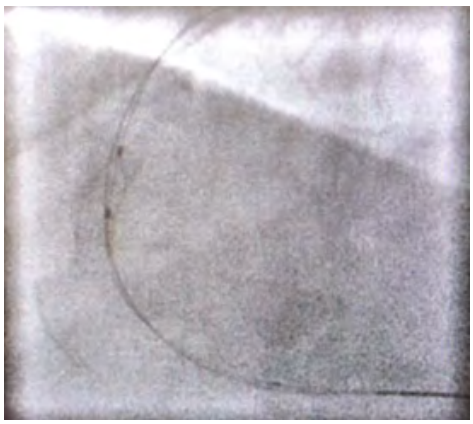


Figure 6a: Post shock wave stent deployed.

End results were very satisfactory and good flow across the RCA (Figure 6b) with significant improvement in his anginal symptoms.

Some studies have shown that efficacy of CSWT can be assessed by Dipyridamole myocardial perfusion imaging or Cardiac MRI or dobutamine stress echocardiogram. However, we did not perform any of those because of patient preference and his symptoms were improved significantly.

Figure 6b: Post PCI, final result.

Discussion

Shock waves (SW) belong to acoustic waves that can be transmitted through a liquid medium and focused with a precision of several millimetres to any intended treatment area inside the body. In Coronary artery disease patients, shock wave can be delivered to the border of the ischemic area. Cardiac shock wave therapy is performed using a shock wave generator system coupled with a cardiac ultrasound imaging system that is traditionally used to target the treatment to area with documented ischemia. Shock waves are delivered via a special applicator through the anatomical acoustic window to the treatment

area (Figure 7).

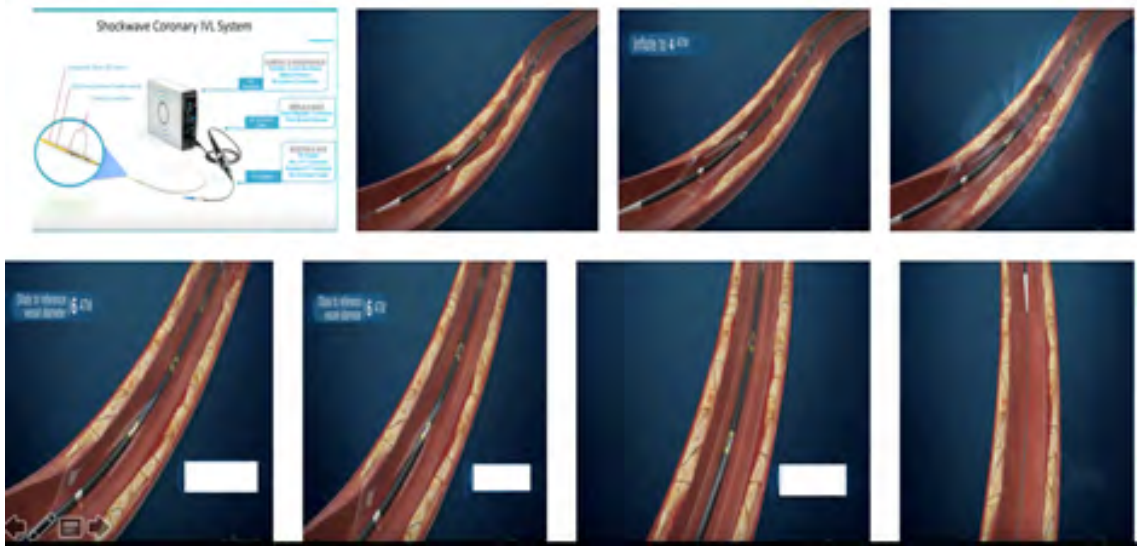


Figure 7: Schematic illustration of device and mechanism.

Cardiac shock wave therapy (CSWT) is considered as novel treatment option in patients with stable CAD presenting with refractory angina. Experimental studies showed that CSWT might induce shear stress to endothelial cells and produce complex cascade of short- and long-term reactions. The mechanism of CSWT action is multifactorial. This ultrasonic shock wave induces the release of angiogenic factor such as endothelial nitric oxide synthetase, vascular endothelial growth factor and proliferating cell antinuclear antigen that stimulate angiogenesis [15,16]. The observed immediate effect is increase in blood flow due to local vasodilation and the formation of new capillaries in the treated tissue [17,18]. Since 1999 [19], cardiac shock-wave therapy (CSWT) as a tool for the management of RFA has been investigated in a considerable number of clinical studies.

The noninvasive nature and fewer adverse events make it as treatment of choice for patient suffering from RFA. However, actual efficacy of this modality is yet to be established. Some systemic reviews of CSWT in stable CAD demonstrate reassuring parameters, including improvement in clinical symptoms such as angina, improved quality of life, LVEF and improved perfusion [20].

Limitations

Although it has been very well tolerated, virtually there are not any adverse effect with reported symptomatic relief and non-invasive nature of CSWT, despite all that it has not been widely practiced. This might be because of expensive equipment, need extra skill and understanding of ultrasound coupled with fact of significant time consumption for whole procedure [21].

Moreover, treatment area needs to be localized; the patients without an adequate echocardiographic window (e.g., overweight, pulmonary disease) might not be an ideal candidate for CSWT. The safety of CSWT use in patients with pacemakers of implantable defibrillators has not been defined yet [20]. Therefore, CSWT can be considered not as a substitutive but as adjunct therapy in case of limited efficacy of optimal medical treatment [21].

Conclusion

Overall, Cardiac shock wave therapy is a promising non-invasive option for patients with end-stage coronary artery disease, but evidence is limited to small sample single-centre studies. Multi-centre adequately powered randomised double blind studies are warranted.

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