

# Case Report

## Cases Report: Experience with Rheolytic Thrombectomy Device (Angiojet) in Acute ST Elevation Myocardial Infarction with Large Amount of Coronary Thrombus

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**Background:** Primary percutaneous coronary intervention (PCI) in acute ST elevation myocardial infarction (STEMI) is a clinical challenge. Adequate thrombus removal before stenting is an important factor that predicts procedural success, and finally reflects to clinical outcomes.

**Cases Report:** In the present report, 2 cases of acute STEMI underwent primary PCI. Coronary angiogram (CAG) in both cases showed a large amount of coronary thrombus (TIMI thrombus grade 4 & grade 5), with no response to several attempts of manual aspiration with thrombus aspiration catheter. Then, Angiojet rheolytic thrombectomy, a catheter-based, device was used antegradely. Repeated CAG showed thrombus was significantly eliminated. Both patients were successfully stented with direct stent technique at culprit arteries, resulted in good angiographic results and inhospital outcomes.

**Conclusion:** Angiojet, a rheolytic thrombectomy device, is a viable option to remove thrombus in primary PCI, especially in cases with massive thrombus load and failed manual aspiration.

**Keywords:** Rheolytic thrombectomy device, Mechanical thrombectomy device, Angiojet, ST elevation myocardial infarction, Percutaneous coronary intervention

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Acute STEMI is the consequence of atherothrombosis secondary to plaque rupture and thrombus formation. Primary PCI to restore epicardial coronary blood flow at culprit vessel is sometimes an extremely difficult situation due to massive thrombus load. This is also associated with poor clinical outcomes due to distal embolization, no reflow and major adverse cardiovascular event (MACE). In the present report, the authors reported 2 cases of primary PCI in acute STEMI setting which did not respond to manual thrombus aspiration.

### Cases Report

#### Case 1

A forty-five year old Thai male was referred from a provincial hospital with complaint of chest tightness for 2 hours. His electrocardiogram (ECG)

showed sinus rhythm and ST segment elevation in V1-V4. He was diagnosed of acute anterior wall STEMI. His echocardiogram revealed akinesia of anterior wall with ejection fraction of 40%. After emergency transferring to cathlab, CAG demonstrated single left anterior descending artery (LAD) disease, TIMI (thrombolysis in myocardial infarction) 1 of coronary blood flow to distal LAD and large thrombus occlusion (TIMI thrombus grade 4) at LAD ostium (Fig. 1A). The interventionist decided to perform primary PCI to the LAD culprit. After 70 unit/kg of heparin and bolus dose of glycoprotein IIb/IIIa inhibitor administered, left main was engaged with Launcher FL 7/4 guiding catheter. Rinato guidewire was easily passed through thrombus containing lesion at LAD. The interventionist performed several attempts of manual thrombus aspiration with ThrombusterII thrombus aspiration catheter, but the amount of thrombus remained unchanged. Although another Rinato guidewire was inserted to septal branch of LAD to make a new track of thrombus aspiration catheter for sucking clot, repeated CAG showed unchanged residual thrombus at LAD ostium (Fig. 1B). Finally, the interventionist decided to use Angiojet, a

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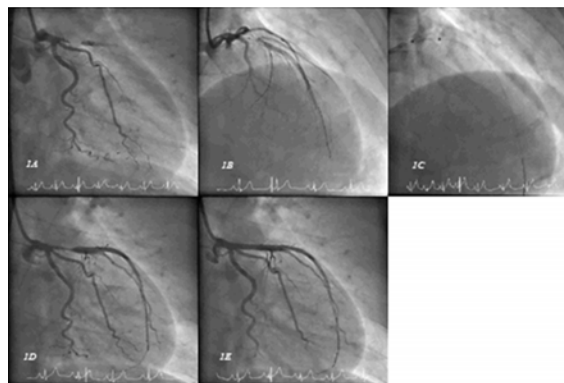
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rheolytic thrombectomy device, to cope with this large amount of thrombus (Fig. 1C). After two runs of antegrade approach of Angiojet, thrombus in the LAD disappeared (Fig. 1D). There were runs of transient sinus bradycardia and sinus arrest while using Angiojet, which were improved by stimulating the patient to cough. Fifty percent residual stenosis at LAD culprit was fixed by direct stenting with Firebird 4.0 x 18 mm stent at 12 atm. Final CAG showed no residual stenosis with TIMI 3 flow to distal LAD (Fig. 1E). Door to thrombus aspiration time was 38 minutes. Total ischemic time was 2 hours 43 minutes. The patient was discharged from the hospital on day 5 after admission.

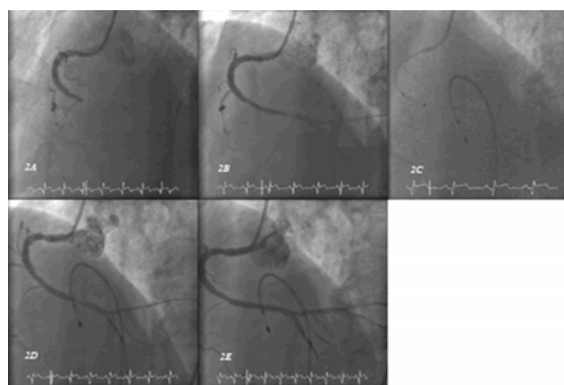
### Case 2

A forty-four years old diabetic male was admitted due to complaint of epigastrium discomfort for 12 hours. Twelve leads ECG revealed sinus rhythm and ST segment elevation in leads II, III, aVf, V3R and V4R. Diagnosis of acute inferior wall STEMI with right ventricular infarction was made. His echocardiogram showed hypokinesia of inferior wall, fair left ventricular contraction, ejection fraction of 50% and hypokinesia of right ventricle. Emergency CAG demonstrated triple vessel disease: 90% stenosis proximal LAD, 80% stenosis mid left circumflex (LCX), ectatic right coronary artery (RCA) with 100% occlusion by thrombus (TIMI thrombus grade 5) and TIMI 0 of coronary blood flow to distal RCA (Fig. 2A). The interventionist decided to perform primary PCI to the RCA culprit. After intravenous heparin and bolus dose of glycoprotein IIb/IIIa inhibitor administered, RCA was engaged with Launcher FR 7/4 guiding catheter. Floppy II and Runthrough NS guidewires were inserted to posterior descending artery (PDA) and posterolateral (PL) branch of RCA respectively. Several attempts of manual thrombus aspiration with Thrombuster II thrombus aspiration catheter via both guidewires were done. Repeated CAG showed unchanged large residual thrombus (Fig. 2B). Angiojet was then selected to cope with this type of coronary lesion again. This time, under prophylactic transvenous temporary pacemaker via left femoral vein for dealing with sinus bradycardia during activating Angiojet, the interventionist performed four antegrade runs of the thrombectomy device with no need to stimulate the patient to cough when sinus bradycardia or sinus arrest occurred (Fig. 2C). Repeated CAG showed small amount of residual thrombus in distal RCA, distal PDA, distal PL, with TIMI II flow to distal PDA and PL branches (Fig. 2D). The culprit lesion was then stented directly with Gazelle 3.5 x 14 mm stent

at 16 atm. Final CAG revealed much improvement of angiographic results and TIMI flow as compared to first CAG (Fig. 2E). Door to thrombus aspiration time was 75 minutes. Total ischemic time was 13 hours 15 minutes. The patient was discharged from the hospital safely after receiving 5 days of adjunctive enoxaparin subcutaneously.



**Fig. 1** Baseline left coronary angiogram from first case depicted large thrombus occlusion at LAD ostium (1A)., Significant residual thrombus after repeated manual aspiration with thrombus aspiration catheter (1B), While using Angiojet device (1C), Minimal residual thrombus after using Angiojet (1D), Final angiogram after direct stenting (1E)



**Fig. 2** Baseline right coronary angiogram from second case illustrated large amount of thrombus at distal RCA (2A)., Significant residual thrombus after repeated manual aspiration with thrombus aspiration catheter (2B), Transvenous temporary pacemaker insertion and performing thrombectomy with Angiojet device antegradely (2C), Minimal residual thrombus at distal RCA before bifurcation of PDA and PL branches (2D), Final angiogram after direct stenting (2E)

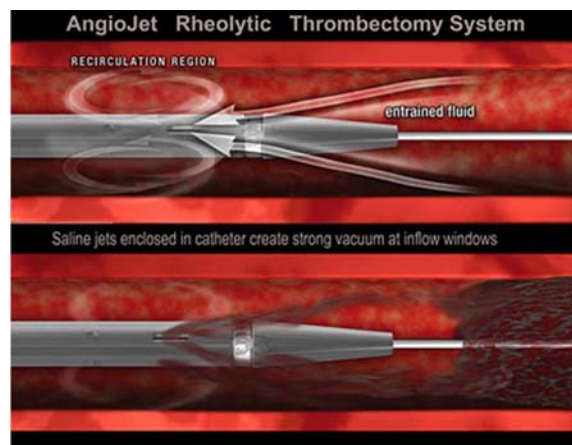
## Discussion

Primary PCI in acute STEMI setting represents a clinical challenge situation as coronary thrombus has been identified as a predictor of adverse outcome<sup>(1,2)</sup>. Distal embolization of thrombus can lead to a varying degree of consequences ranging from asymptomatic cardiac enzyme leak to no reflow phenomenon, which increases cardiovascular events. Both manual and mechanical thrombectomy devices are also an appealing adjunctive therapy for thrombus-containing lesions, given their potential for decreasing the size of thrombus, decreasing distal embolization and improving clinical outcomes. Angiojet, one of mechanical thrombectomy devices available, has been studied in a number of clinical trials. Mechanism of thrombus removal by Angiojet is high velocity saline jets created within distal catheter tip create a strong negative pressure (Bernoulli effect), whereas the most common complication which occurs while operating Angiojet device is arrhythmic complication.

Based on clinical trials of manual thrombectomy device (dominated by TAPAS trial<sup>(3)</sup> and EXPIRA trial<sup>(4)</sup>), both ACC/AHA 2009 guidelines for the management of patients with ST-elevation myocardial infarction<sup>(5)</sup> and ESC 2010 guidelines for myocardial revascularization<sup>(6)</sup> have given aspiration thrombectomy a class IIa. The ACC/AHA 2009 guidelines gave level of evidence B, whereas the ESC 2010 guidelines upgraded to level of evidence A. In the present report, the situation in both cases were large amounts of thrombus which did not respond to several attempts of manual aspiration with thrombus aspiration catheter, finally required mechanical thrombectomy device. Angiojet has been approved by USFDA for removing thrombus in the treatment of patients with symptomatic coronary and saphenous vein graft lesion in vessels more than 2.0 mm since 1999. Prior to study of Angiojet in acute myocardial infarction, the AIMI trial<sup>(7)</sup>, showed a negative result. The AIMI trial enrolled 480 patients, did not show any difference in ST-segment elevation resolution between thrombectomy arm and control, while infarct size as assessed by <sup>99m</sup>Tc sestamibi scintigraphy was larger and 1-month MACE rate was higher in the thrombectomy arm as compared with control (4.6% and 0.8%, respectively;  $p = 0.02$ ). Result of AIMI trial was criticized as occurred by exclusion patients with large amounts of thrombus (only 21% of patients had evidence of moderate or large thrombus), using Angiojet with retrograde technique and high delay from admission to randomization ( $> 2.5$  h). However, a recent study of Angiojet in acute myocardial infarction, the

JETSTENT trial<sup>(8)</sup>, included 501 patients with moderate to a large amount of thrombus (TIMI thrombus grade 3-5), using antegrade technique, represented a positive result. The JETSTENT trial randomized patients into rheolytic thrombectomy (Angiojet) before direct stenting (RT arm) or to direct stenting alone (DS alone arm). The ST-segment elevation resolution was more frequent in the RT arm as compared with the DS alone arm: 85.8% and 78.8%, respectively ( $p = 0.043$ ). The 1-year event-free survival rates were  $85.2 \pm 2.3\%$  for the RT arm and  $75.0 \pm 3.1\%$  for the DS alone arm ( $p = 0.009$ ).

The Angiojet rheolytic thrombectomy system (Medrad Interventional/Possis, Minneapolis, Minnesota) consists of a drive unit console, a disposable pump set and a 4-F disposable catheter. The drive unit console generates high-speed pulsed flow (40 ml/min) pushed into a high-pressure lumen of the catheter. This lumen ends up in a 180° loop that separates into 6 high-pressure jets, directed retrograde into the collecting lumen of the catheter. Thrombectomy is accomplished with high-velocity saline jets at a speed of about 450 km/hr contained within the distal catheter tip. These jets create a strong negative pressure (Bernoulli effect) that entrains the thrombus to the catheter inflow windows, where it is captured, fragmented and evacuated from the body through the catheter and associated tubing (Fig. 3). According to the JETSTENT trial, the single-pass antegrade thrombectomy technique includes: 1) catheter activation at least 1 cm proximal to the thrombus, to create a suction vortex before advancing the device; 2) advancing the thrombectomy catheter slowly (1 to 3 mm/s) to and through the thrombosed segment and 3) restarting the



**Fig. 3** Angiojet distal catheter tip (Photo courtesy of Medrad Interventional/Possis, Minneapolis, MN)

thrombectomy at the end of the proximal-to-distal pass, with a distal-to-proximal pullback. After the first pass, the device was retrieved into the guide catheter, and an angiographic check was performed to assess restoration of TIMI flow. If a TIMI flow grade 2 or 3 was restored and there was no more evidence of residual thrombus, thrombectomy treatment was stopped, whereas a second or third pass could be made if there was evidence of residual thrombus or a TIMI flow grade < 2. In the present report, after failure to aspirate thrombus manually, the operator activated 2-4 antegrade runs of Angiojet for eliminating large amount of thrombus. In both cases, minimal residual thrombus and satisfactory angiographic results were gained before stenting directly to culprit lesions.

Most common complication during activating Angiojet is temporary cardiac rhythm disturbances such as sinus bradycardia, asystole, high-grade atrioventricular block or complete heart block. Incidence of these complications has been reported in 20-26% of cases involving rheolytic thrombectomy<sup>(9)</sup>. A postulated mechanism of this phenomenon is release of intracellular adenosine from hemolyzed red blood cells<sup>(10)</sup>. Adenosine serves as a coronary vasodilator (A2 receptor subtype mediated) with negative chronotropic effect, as well as anti-beta-adrenergic effect (A1 receptor subtype mediated). Adenosine released from hemolyzed red blood cells are directed to the vessels supplying the sinoatrial and atrioventricular node and impact conduction and heart rate. Interventions on the right coronary artery or dominant left circumflex artery are particularly susceptible to this situation due to its arterial supply to the atrioventricular node. Medication such as aminophylline, a methylxanthine and a competitive inhibitor of the adenosine receptor, may prevent rheolytic thrombectomy-associated bradyarrhythmias, however, results from clinical trials are still contro-versial<sup>(10,11)</sup>. Some operators recommend prophylactic insertion of temporary pacemaker catheter in the right ventricle prior to the activation of Angiojet, but some operators disagree as they found that, in their practice, bradycardia was quickly aborted by deactivation the Angiojet and allowing the heart rhythm to return to normal. Prophylactic temporary pacemaker may be needed only in the hemodynamically unstable patient in whom brief episodes of bradycardia may not be tolerated. Fortunately, from contemporary clinical trial such as the JETSTENT trial, the percentage of temporary pacemaker insertion to prevent or treat severe bradycardia is quite low (0.7%)<sup>(8)</sup>. Regarding

case 1 in the present report, intervention to the LAD, which is not arterial supply to sinoatrial or atrioventricular node, was also associated with transient sinus bradycardia and sinus arrest. This bradyarrhythmia was improved by deactivating the Angiojet for a few seconds and stimulating the patient to cough, which had vagolytic effect. Regarding case 2 in the present report, temporary pacemaker was inserted to prevent episodes of bradyarrhythmia or heart block while performing intervention to the RCA.

In conclusion, although current guidelines from ACC/AHA 2009 and ESC 2010 support the use of manual thrombus aspiration, the authors reported 2 cases of primary PCI in acute STEMI setting with a large amount of thrombus did not respond to simple manual aspiration, finally required rheolytic thrombectomy device. With regard to result of the present report, Angiojet rheolytic thrombectomy device may have a place in the acute MI treatment armamentarium to improve clinical outcomes for patients experiencing acute STEMI, especially in high risk cases with massive thrombus load.

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#### **Potential conflicts of interest**

None.

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รายงานการรักษาผู้ป่วยกล้ามเนื้อหัวใจตายเฉียบพลันชนิด ST elevation ที่มีปริมาณลิ่มเลือดอุดตันในหลอดเลือดแดงโคโรนารีเป็นปริมาณมากโดยใช้อุปกรณ์แองจิโอเจทในการสลายและดูดลิ่มเลือดออก

ธรรมรัฐ ฉันทแดนสุวรรณ, วิรัช เคหสุขเจริญ, เกரியงไกร เสงวีรัมย์

**ภูมิหลัง:** การทำการขยายหลอดเลือดแดงหัวใจที่ตีบตันในภาวะกล้ามเนื้อหัวใจตายเฉียบพลันชนิด ST elevation นั้นถือเป็นสิ่งที่ท้าทายความสามารถของอายุรแพทย์โรคหัวใจเป็นอย่างยิ่ง การที่สามารถกำจัดลิ่มเลือดที่พบอยู่ที่บริเวณรอยโรคได้อย่างเพียงพอเป็นตัวแปรสำคัญ ที่จะบ่งบอกถึงโอกาสประสบความสำเร็จก่อนที่จะทำการถ่างขยายเส้นเลือดหัวใจด้วยขดลวดต่อไป (direct stent) รวมทั้งส่งผลกระทบต่อผลการรักษาทางคลินิกของผู้ป่วยอีกด้วย

**รายงานผู้ป่วย:** ผู้นี้พินธ์ได้นำเสนอรายงานผู้ป่วย 2 รายที่มีภาวะกล้ามเนื้อหัวใจตายเฉียบพลันชนิด ST elevation ที่ได้รับการขยายหลอดเลือดแดงหัวใจในขณะที่เกิดภาวะนี้ เมื่อผู้ป่วยทั้ง 2 ราย ได้รับการฉีดสีตรวจหลอดเลือดหัวใจพบว่าทั้ง 2 ราย มีลิ่มเลือดอุดตันอยู่ที่บริเวณเส้นเลือดแดงโคโรนารีเส้นที่ก่อโรคอยู่เป็นปริมาณมาก (TIMI thrombus grade 4 & 5) หลังจากที่ผู้ป่วยทั้ง 2 ราย ได้รับการดูดลิ่มเลือดโดยใช้สายดูดลิ่มเลือดหลายครั้งแต่กลับไม่เป็นผลสำเร็จ เนื่องจากยังคงเหลือลิ่มเลือดที่ตักค้างอยู่อีกจึงได้มีการใช้อุปกรณ์แองจิโอเจทในการสลายและดูดลิ่มเลือดออก พบว่าหลังการใช้อุปกรณ์แองจิโอเจททำให้ปริมาณลิ่มเลือดที่ตักค้างเหลือน้อยมากจนสามารถทำการถ่างขยาย เส้นเลือดหัวใจด้วยขดลวด (direct stent) ได้ส่งผลให้ประสบผลสำเร็จในการขยายเส้นเลือดหัวใจและไม่มีภาวะแทรกซ้อนอื่นๆ ในระหว่างที่คนไข้ทั้งสองยังอยู่ในโรงพยาบาล

**สรุป:** อุปกรณ์สลายลิ่มเลือดแองจิโอเจทนั้นมีประสิทธิภาพดีในการสลายและดูดลิ่มเลือดออกระหว่างการขยายเส้นเลือด หัวใจที่ตีบในภาวะกล้ามเนื้อหัวใจตายเฉียบพลันชนิด ST elevation และเป็นอุปกรณ์เสริมอีกชนิดหนึ่งที่น่านำไปใช้โดยเฉพาะในผู้ป่วยรายที่มีลิ่มเลือดอุดตันหลอดเลือดแดงหัวใจอยู่เป็นปริมาณมากที่ไม่ตอบสนองต่อการใช้สายดูดลิ่มเลือดปกติ

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