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Intra-aortic Balloon Occlusion for Refractory Cardiac Arrest in a Patient with Anterior Myocardial Infarction

Ön Duvar Miyokart Enfarktüslü Bir Hastada Gelişen Yanıtsız Kalp Durmasında İntra-aortik Balon Oklüzyonu Kullanımı

CASE REPORT
OLGU SUNUMU

ABSTRACT

Despite recent advances in its management, the outcome of cardiac arrest is often poor despite appropriate cardiopulmonary resuscitation. The arteriovenous perfusion gradient achieved during cardiopulmonary resuscitation is associated with the successful return of spontaneous circulation. Continuous balloon occlusion of the descending aorta is an experimental method that can occlude the "unnecessary" part of the circulation, thus diverting generated pressure and blood flow to the heart and brain. In this study, we present a case report of a patient unresponsive to standard cardiopulmonary resuscitation, in whom constant intra-aortic balloon occlusion achieved a return of spontaneous circulation and successful survival.

Keywords: Cardiopulmonary resuscitation, myocardial infarction, percutaneous coronary intervention, resuscitative endovascular aortic occlusion, sudden cardiac death

ÖZET

Tedavisindeki son gelişmelere karşın, kalp durmasının sonlanımları uygun yapılan kardiyopulmoner resüsitasyona rağmen halen çok kötüdür. Kardiyopulmoner resüsitasyon sırasında oluşturulan atreiyovenöz basınç gradiyenti spontan dolaşım dönüşü ile ilişkilidir. İnen aortanın balon ile sürekli oklüzyonu dolaşımın "gereksiz" kısmının çıkartıldığı ve böylece oluşturulan basınç ve kan akımının kalp ile beyine yönlendirildiği deneysel bir yöntemdir. Bu çalışmada, standart kardiyopulmoner resüsitasyona yanıtsız olan ve sürekli intraaortik balon oklüzyonu ile spontan dolaşımın geri döndürülebildiği, sonrasında da başarılı sağkalımın sağlandığı bir olguyu sunuyoruz.

Anahtar Kelimeler: Ani kardiyak ölüm, kardiyopulmoner resüsitasyon, miyokart enfarktüsü, perkütan koroner girişim, resüsitatif endovasküler aortik oklüzyon

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During cardiopulmonary resuscitation (CPR), the probability of return to spontaneous circulation (ROSC) and good neurological survival are closely correlated with arteriovenous pressure gradient (AVPG).[1]

Resuscitative endovascular occlusion of the descending aorta (REBOA) with ongoing CPR may increase AVPG by limiting arterial circulation to the upper part of the body and increasing aortic pressures.[1,2] Special catheters were designed for this purpose to be used in patients with traumatic or hemorrhagic shock or cardiac arrest, which can be placed by surgeons, non-surgeons, and in the in- or out-of-hospital setting.[3-5] Interestingly, despite the use of REBOA and its supporting evidence are expanding in trauma and hemorrhage field, its use in non-traumatic sudden cardiac arrests did not gather much attention. Since we reported the first successful case of REBOA with usual intra-aortic balloon pump catheter in a refractory in-hospital cardiac arrest (IHCA) more than 10 years ago,[1] the use of REBOA was reported only in a limited number of patients with non-traumatic cardiac arrest in the cardiology setting.[6-8]

In this study, we present a case of anterior myocardial infarction, who developed sudden cardiac arrest during angiography, did not respond to standard CPR, and eventually, REBOA achieved ROSC and successful survival.

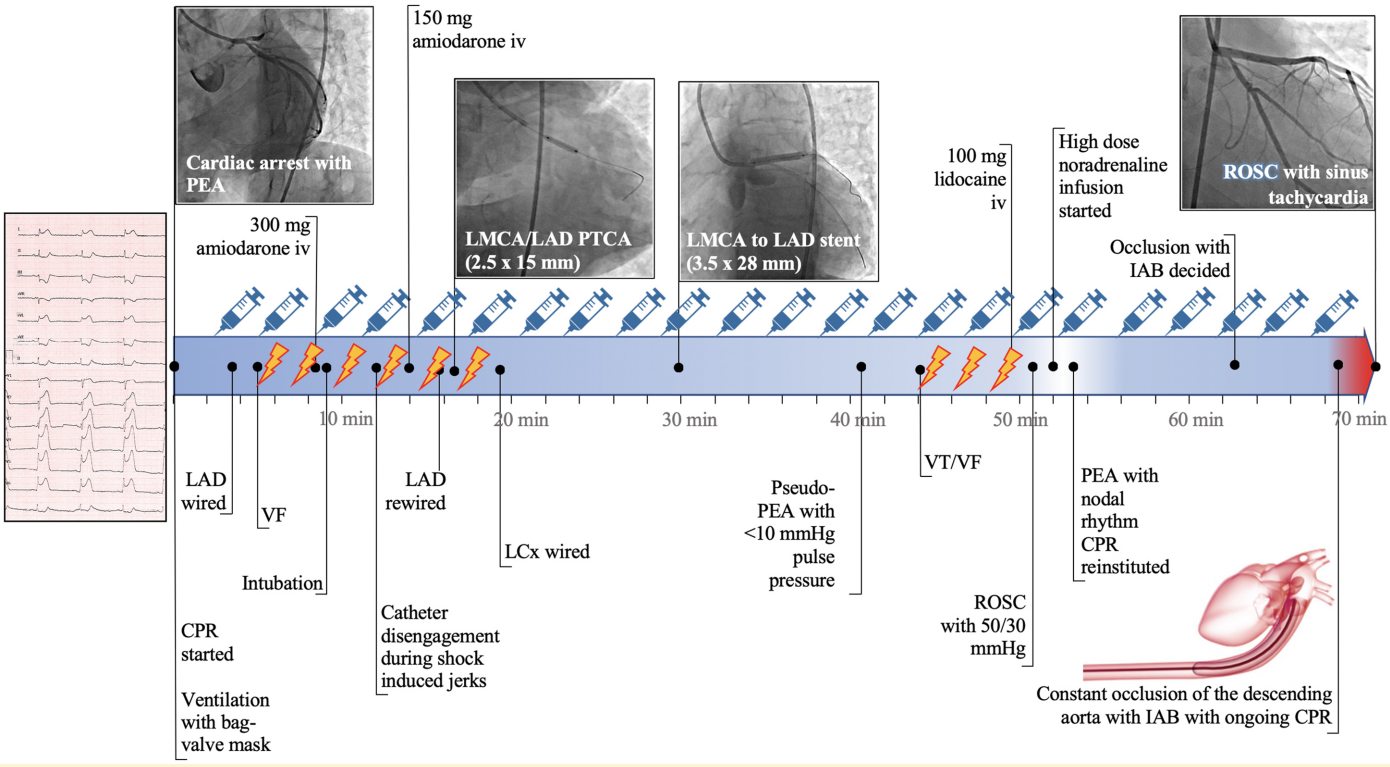

Figure 1. The overview of cardiopulmonary resuscitation. , defibrillation attempts; , adrenaline boluses. CPR, cardiopulmonary resuscitation; IAB, intra-aortic balloon; LAD, left anterior descending artery; LCx, left circumflex artery; LMCA, left main coronary artery; PEA, pulseless electrical activity; PTCA, percutaneous transluminal coronary angioplasty, ROSC, return of spontaneous circulation; VF, ventricular fibrillation; VT, ventricular tachycardia.

Case Report

A 46-year-old male, with no past medical history, presented to our emergency department with 1 hour of crushing chest pain. His electrocardiogram (ECG) showed ST-segment elevation in anterior leads. The patient was immediately transferred to the catheterization laboratory. Oral 300 mg aspirin, 180 mg ticagrelor, and intravenous 10 000 U of heparin were given. The first coronary injection revealed an ostial left anterior descending artery occlusion. After the second injection, the patient developed sudden cardiac arrest. Cardiopulmonary resuscitation was started and advanced life support was performed according to the guidelines (Figure 1).

During CPR, the left anterior descending (LAD) artery was wired at the 3rd minute, but as the catheter disengaged during CPR and defibrillation attempts (12th minute), it had to be rewired again (16th minute). A balloon dilatation with a 2.5 × 15 mm balloon was performed in the left main coronary artery at the 17th minute. Then, the left circumflex artery was wired for protection (18th minute) with a second floppy guidewire, and a 3.5 × 28 mm stent was deployed extending from the left main coronary artery ostium to the proximal LAD. The balloon dilatation and stent deployment were done under constant CPR with minimal interruptions. Twenty minutes after stent deployment, a brief spontaneous circulation was observed with very low blood pressures (Figure 1), which again turned into pulseless electrical activity with nodal rhythm, and CPR was reinstituted. Following failed attempts to achieve a stable ROSC despite revascularization, the use of REBOA was decided nearly 40 minutes after stent implantation (Figure 1).

A 40-mL intra-aortic balloon pump (IABP) catheter was chosen according to the patient's body size, inserted via femoral route, and advanced to the level of arcus aorta so that its tip would be located just distal to the left subclavian artery origin and hand-inflated with air using a 50-mL syringe until a slight resistance was felt on the plunger. Two minutes after occlusion, a rhythm-check pause revealed ROSC. The balloon was deflated and counter-pulsation with a 1:1 ratio was started along with a noradrenaline infusion of 0.1 µg/kg/min. During the first 12 hours of follow-up, the noradrenaline dose was gradually weaned down and counter-pulsation was stopped. The patient was extubated the next day. On the following day, the patient's overall performance category and cerebral performance category scores were both 1. The high-sensitive troponin-T peaked at >10 000 ng/L. His echocardiogram showed apical anterior hypokinesis with

ABBREVIATIONS

AVPG	Arteriovenous pressure gradient
CPR	Cardiopulmonary resuscitation
IABP	Intra-aortic balloon pump
IHCA	In-hospital cardiac arrest
ECG	Electrocardiogram
LAD	Left anterior descending artery
OHCA	Out-of-hospital cardiac arrest
REBOA	Resuscitative endovascular occlusion of the descending aorta
ROSC	Return of spontaneous circulation

an ejection fraction of 50%. The patient underwent a second procedure on the seventh day, in which the left main coronary artery stent was dilated with a 4.5 × 10 mm non-compliant balloon. He was discharged on 12th day after admission.

Discussion

Many organs can endure ischemia much better than the heart and the brain; therefore, the main priority of CPR is the perfusion of these 2 organs. The AVPG, as a surrogate for the perfusion of these 2 critical organs, has been shown to be one of the most critical determinants of ROSC and neurologically intact survival. Although standard CPR with chest compressions and adrenaline can increase AVPG, the pressure generated by these maneuvers is greatly dissipated while the whole vascular tree is being perfused. The occlusion of the descending aorta can limit circulation and divert the blood flow to the heart and the brain.[1]

The use of REBOA in trauma and major hemorrhage has been showing an increasing trend in recent years. This may partly reflect that the rationale for its use in these situations may be more appealing as it primarily aims to limit blood loss. In non-traumatic arrest, however, REBOA during chest compressions targets only occlude the "unnecessary" part of the circulation and increases AVPG.[1] Since we reported the first successful case of REBOA in a refractory nontraumatic in-hospital cardiac arrest (IHCA) more than 10 years ago, only 1 more case report using REBOA as a bridge to IABP,[6] 1 retrospective case series including 11 nontraumatic out-of-hospital cardiac arrest (OHCA) cases,[7] and 1 observational study comprising 10 patients with OHCA[8] were reported. Considering approximately 3% of all IHCAs occur in the cardiac catheterization laboratory, the paucity of reports in the coronary intervention setting indicates that the potential of this method is underappreciated and underutilized. Actually, the use of REBOA is especially feasible in the catheterization laboratory. In this regard, the presented case is the first concerning a myocardial infarction patient who was unresponsive to the acute opening of infarct-related artery and standard resuscitation maneuvers and in whom REBOA successfully achieved ROSC. The patient also survived to discharge with intact neurological status despite more than 1 hour of active CPR.

There are several limitations to this report. Obviously, a simple case report is not enough to establish a cause-and-effect relationship between intra-aortic balloon occlusion and ROSC. Second, we were not able to document the hemodynamic effects of intra-aortic balloon occlusion. Although we observed a significant increase in the aortic pressures during balloon inflation, despite the chest compression deliverers, who were unaware of the balloon inflation and were giving chest compressions with a similar degree of effort, the aortic pressure recordings were forgotten to be stored in the mayhem of CPR. The complete cessation of the descending aortic flow could be confirmed by the loss of the arterial waveforms from the femoral sheath side-port, but this was not done. However, complete balloon occlusion may not be a sine-qua-non prerequisite for increasing proximal aortic pressures, as a substantial increase in the resistance to outflow may provide enough pressure to build up in the proximal aorta.

Conclusion

This report indicates that intra-aortic balloon occlusion in the cardiac catheterization laboratory is feasible and may be an effective adjunct to the standard CPR in patients who develop sudden cardiac arrest during cardiac catheterization and do not quickly respond to the standard interventions.

Informed Consent: Written informed consent was obtained from the patient.

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Declaration of Interests: The authors declare that they have no competing interest.

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