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How-to-do-it

# Closure of left ventricle perforation with the use of muscular VSD occluder

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**Abstract**

Growing experience in interventional cardiology leads to the use of large diameter of vascular equipment. In some instances, the so-called hybrid procedures are performed. After performing the interventional procedure, the opening in ventricular wall is closed surgically. Our intention was to check if the MVSDO can be used to close the perforation in the heart after the interventional cardiology procedure performed through the left ventricular (LV) free wall. In three pigs under general anesthesia, the heart was exposed through a small substernal incision. The LV was punctured and an 18F sheath was introduced into the LV. A 14 mm MVSDO was inserted through the 10F Delivery System. Using both the echocardiographic and angiographic guidance, the MVSDO was placed on the LV wall to close the opening in the LV. Time and volume of bleeding was recorded. In all cases the occluder was successfully placed closing the opening, bleeding observed after deployment of occluder lasted for approximately 2 min. We think MVSD occluder can be used to close the LV free wall perforation after hybrid interventional cardiac procedure. Early bleeding through MVSDO might be resolved by the manufacturing of new occluder with better sealing properties.


*Keywords:* Amplatzer device; Interventional cardiology; Hybrid cardiology procedures

## 1. Objective

Growing experience in interventional cardiology leads to use of larger vascular equipment [1–6]. Low weight and small diameter of access vessels limits use of these methods in some patients [7].

Sometimes the heart is exposed surgically in order to directly puncture the heart cavity. After performing this interventional procedure, the perforation in the ventricular free wall is closed surgically. This combination of surgical and interventional cardiologic techniques is called a 'hybrid procedure' [1].

*The aim of the study* was to verify if MVSDO can be used to close the perforation in the heart after an interventional cardiology procedure performed through left ventricular (LV) free wall.

## 2. Methods

In compliance with the European Convention on Animal Care, and with permission of the Ethic Committee of University Hospital CHUV in Lausanne, an experiment was performed on three pigs weighting 55–58 kg. Under general anesthesia they were intubated and mechanically ventilated. Classic ECG monitoring was used. A catheter was inserted into left brachiocephalic vein for drug infusion and one catheter into the left common carotid artery for blood pressure monitoring, sampling and analysis ($pO_2$, $pCO_2$, $SatO_2$, Ht, K, Na). Intracardiac ultrasound transducer 12, 5 MHz (Boston Scientific) was inserted into LV through a 9F sheath placed in right common carotid artery. This was used to visualize the interior of the LV. Another echo-probe (IVUS, 8, 5 MHz Acuson) was inserted into Inferior Vena Cava through a 10F sheath placed in right femoral vein. They were used to monitor the course of procedure. An approximal substernal 5 cm incision was made and the pericardium was opened and suspended for better heart visualization (Fig. 1a). Intravenous Heparin was administrated in the amount of 100 U/kg b.w. to keep the ACT at 200s. The LV was punctured with a needle and guide wire. A 9F dilator and 18F sheath were introduced into LV cavity. The 14 mm MVSDO was inserted through the 10F Delivery System. Under both echocardiographic and angiographic guidance, the distal MVSDO disc was opened and pulled back to the LV wall. Finally, the proximal disc was opened closing the LV perforation. After proper location of the MVSDO was confirmed by echo and angiography, the occluder was detached (Fig. 1a and b). A pericardium was closed with

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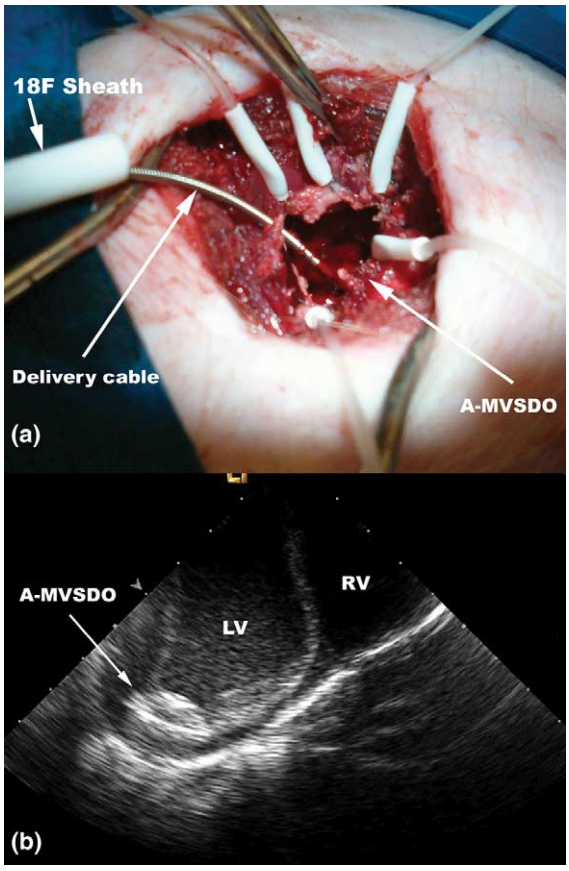


Fig. 1. (a) The A-MVSDO completely opened connected with delivery cable through the substernal incision (18F sheath—external diameter 8 mm). (b) IVUS echocardiogram showing the A-MVSDO completely opened on the LV wall.

drainage tube left in place. Time and volume of bleeding was recorded. The animals were monitored for the next 3 h. At the end an autopsy was performed—attention was paid to the position of the occluder and eventual thrombus formation inside the LV.

## 3. Results

In all three cases, the occluder was successfully placed in closing the perforation of the LV free wall. The entire procedure was safely monitored by both intravascular and intracardiac echoprobes. Opening of both the occluder discs was performed precisely and did not require any repositioning.

After deployment of the occluder, bleeding through the occluder lasted approximately 2 min. In one case, there was a low of (58/29 mmHg) arterial blood pressure noticed just after the implantation. In this case, the bleeding volume was much smaller in comparison with other two animals with normal blood pressure (Table 1).

Single ventricular extrasystoles (VES) were common during puncturing and introduction of the sheath. This resolved spontaneously and did not require medication. The procedure took one half to 1 h from skin cut to closure of the wound. During the consecutive 3 h follow-up time, drainage below 10 cc an hour was observed in all cases.

During follow-up after implantation of the occluders, there were no disturbances in the LV contractility noticed with echocardiographic examination. In this period, there were normal blood gas and electrolytes values in the blood samples. In one case, a thrombus formation was suspected. Proper values were confirmed upon an ACT check. The autopsy did not confirm thrombus formation in this animal.

At autopsy, the proper position of the occluder and absence of important thrombus formation in its region were confirmed. There was a small thrombus found in one animal close to occluder.

## 4. Discussion

We confirmed that MVSDO can be used for closure of the LV free wall opening left after penetration with large diameter sheath used for interventional procedures. The bleeding volume through and around the occluder was important. The bleeding stopped within the first 2 min and did not continue. This observation is different from our experience with application of occluder for the closure of right ventricular perforation [8]. The difference in the amount of bleeding is possibly caused by higher LV pressure and might explain the smaller bleeding amounts in one animal with lower blood pressure.

Transient VES were noted during penetration of LV wall. This cause is due to the mechanic irritation of the myocardium. These disturbances vanished after the deployment of the occluder. The occluder did not cause any heart rhythm disturbances in any case after implantation.

In one pig, thrombotic complication was suspected. This was not confirmed at autopsy.

Table 1
The course of consecutive experiments

| Pig no. | Age | Weight (kg) | Bleeding (ml) | Blood pressure | Thrombus in ECHO | ACT | Autopsy |
|---|---|---|---|---|---|---|---|
| 1M | 8 w. | 58 | 50 | 59/28/37 | Small between papillary muscles | 200s | No thrombus. Good location of occluder |
| 2F | 8 w. | 58 | 650 | 98/56/68 | No | 280 | No thrombus. Good location of occluder |
| 3M | 8 w. | 55 | 800 | 91/53/65 | No | 271 | Small thrombus at occluder and adjacent wall |

## 5. Conclusion

(1) MVSD device can be used to close LV free wall opening after interventional cardiologic procedure.
(2) Early bleeding through MVSDO might be solved by the manufacturing of new occluders with better sealing properties.

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