it seems that the combination of VA-ECMO plus Impella/intra-aortic balloon pump is the most favorable option.[4] A special situation is the presence of pulmonary edema due to pulmonary hyperflow following left-to-right shunt. It looks like optimizing the left ventricular discharge could improve this situation by reducing the Qp/Qs ratio. However, management is still controversial. We have been gaining experience with percutaneous closure and it has been used as the definitive treatment in the management of small VSDs, and as a bridging therapy to surgery with larger VSDs although with risk of failure and embolization involved. Its use has also been reported in residual VSDs after cardiac surgery.[5]

In conclusion, the management of postmyocardial infarction VSD is controversial. Surgery is the treatment of choice, and it seems like delaying surgery increases the chances of success. However, the optimal waiting time is still unknown. The use of mechanical support can prevent hemodynamic deterioration being VA-ECMO an attractive therapeutic option. Percutaneous closure can be an alternative in certain settings. Finally, evidence on this regard is scarce and based on observational studies only and questions still abound.

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AUTHORS' CONTRIBUTIONS

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CONFLICTS OF INTEREST

None reported.

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Retrograde closure of perimembranous ventricular septal defects. A paradigm shift

Cierre percutáneo de comunicaciones interventriculares perimembranosas por vía retrógrada. Cambio de paradigma

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To the Editor,

The percutaneous closure of ventricular septal defect (VSD) is still not widely used today due to its potential complications (atrioventricular block, valvular heart disease, hemolysis), and technical limitations, particularly, in low-weight patients.[1]

Devices specifically designed for the closure of perimembranous VSD (pmVSD) have an asymmetric design that conditions implantation via antegrade venous access. Therefore, the standard procedure requires creating an arteriovenous loop across the defect to advance the device until its sequential release from the aorta or the left ventricle. An example of this is the Nit-Occlud Lê VSD-Coil device (PFM Medical, Germany) that has a good safety and efficacy profile.[2] However, the creation of the loop can be the cause for transient atrioventricular blocks and hemodynamic instability especially in low-weight patients.[3] Also, the use of different unspecific occluders—with good clinical outcomes—for this indication has been described, especially if the defect comes with aneurysmal tissue.[4] Thanks to their symmetric design and low profile, some devices can be released from the arterial side (retrograde), thus avoiding the creation of the loop. This simplifies the technique, shortens procedural time, and minimizes the dose radiation received by the patient. Such approach has already been described with good clinical outcomes with a specific design for the closure of the VSD, the Konar-MF (Lifetech, China).[5] Given these potential benefits, we decided to start using this technique back in September 2019.

Ever since, transarterial retrograde access has been used in 12 out of every 20 patients treated with the percutaneous or posteroperative closure of VSD. This approach became consolidated during the learning curve and ended up being the approach of choice when

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Table 1. Patients treated with percutaneous closure of perimembranous ventricular septal defect via retrograde access

Patient	Age	Weight (kg)	Underlying heart disease	Indication for closure	Diameter of VSD in the LV Echo (mm)	Qp/Qs ratio	X-ray image time (min)	Success	Immediate complications	Fr	Device	Device waist	Follow-up (m)	Complications at follow-up	Cause of death
1	26 y	48	pmVSD	Postop	8.4	1.4	12.5	Partial	No	8	ASO	12	58	No	
2	8.4 y	24.5	pmVSD	Echo	7	1.4	11.6	Yes	No	5	ADO II	5	71	No	
3	4.9 y	20.5	pmVSD	Echo	4.5	1.5	15.3	Yes	No	4	ADO II	4	59	No	
4	6 m	2.7	pmVSD	Echo	4	3	20.3	Yes	Embolization	4	ADO II	4	12	Death	LTE in syndromic patient (mucopolysaccharidosis)
5	8 m	5.7	pmVSD	Postop	3	1.4	17.8	Yes	No	5.5	Piccolo	5	65	Death	Refractory pulmonary hypertension in complex heart disease (Shone complex)
6	3.2 y	24	pmVSD	Echo	4.5	1.5	10.4	Yes	No	6	Piccolo	5	33	No	
7	2 m	6	pmVSD	Postop	3.3	1.4	31.8	Yes	No	4	Piccolo	5	2	Death	Postoperative aortitis
8	38 y	100	TOF	Postop	7	1.5	16.4	Yes	No	8	ADO I	12	51	No	
9	12.5 y	36	DCRV	Postop	5	1.3	7.1	Yes	No	5	Konar	10	11	No	
10	2.9 y	18.4	pmVSD	Echo	8	1.5	17.2	Yes	No	5	Konar	8	11	No	
11	2.2 y	13	pmVSD	Echo	4	1.5	15.4	Yes	No	5	Konar	6	9	No	
12	12.6 y	48.5	pmVSD	Echo	3.5	2	13.2	Yes	No	5	Konar	7	6	No	

DCRV, double-chambered right ventricle; Echo, repercussion on echocardiography; Fr, French; kg, kilogram; LTE, limitation of therapeutic effort; LV, left ventricle; m, months; min, minutes; mm, millimeters; pmVSD, perimembranous ventricular septal defect; Postop, postoperative; Qp/Qs ratio, pulmonary flow/systemic flow; TOF, tetralogy of Fallot; VSD, ventricular septal defect; y, years.

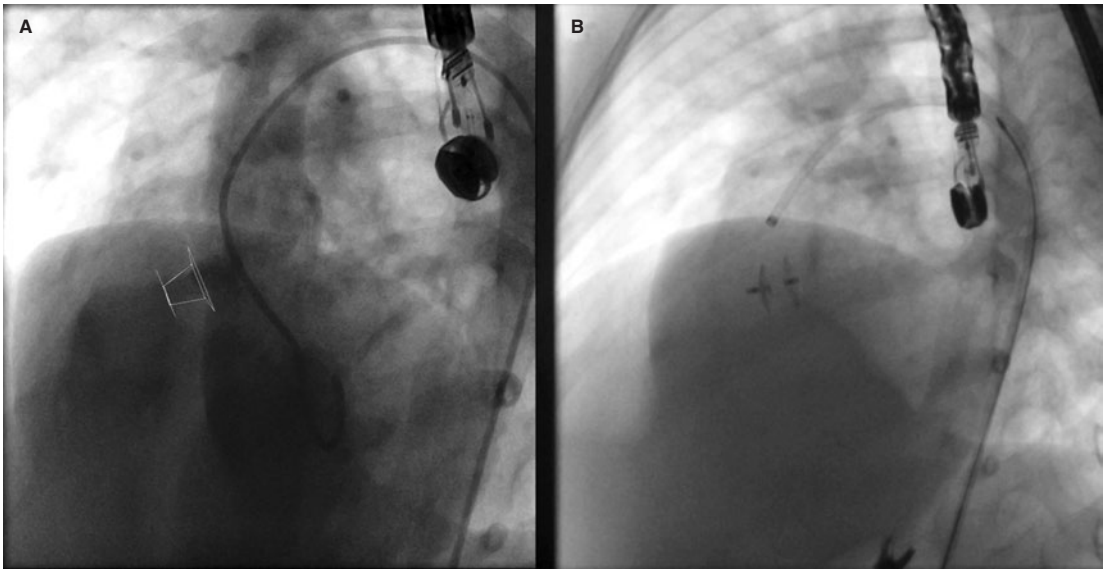

Figure 1. Patient #10. **A:** Angiography and graphic representation of the Konar-MF device. **B:** Konar-MF final implantation position.

dealing with favorable anatomies: non-supracristal perimembranous single defects without coronary leaflet prolapse, at least, 3 mm away from the aortic annular plane of < 6 mm in the right entrance and preferably with aneurysmal tissue. Different occluders with symmetric design were used like the ADO II (patient #4; videos 1 and 2 of the supplementary data), the Piccolo (patient #5; videos 3 and 4 of the supplementary data), the ASO (Abbott) or the Konar-MF (patient #10; videos 5 and 6 of the supplementary data). We included the retrograde use of the ADO device (Abbott) in a patient with postoperative residual VSD without aortic edge with good clinical outcomes.

Procedure was scheduled in all the patients and performed under general anesthesia and with mechanical ventilation. Catheterization

of the VSD and the right ventricle was performed with a right coronary artery curve catheter and a 0.035 in hydrophilic guidewire. A Teflon-coated exchange guidewire was placed in the right ventricular apex, 1 catheter carrying the device was mounted on it and moved forward. Sequential release started from the right ventricular apex until contacting the defect. Afterwards, the retention body and disc were released while protected by the catheter across the aortic valvular plane. Monitorization during the procedure was performed under echocardiography (transthoracic if < 10 kg, transesophageal in the remaining cases) and angiography guidance through the carrier catheter. Final hemostasis occurred through manual compression.

The patients' median age and weight were 4 years (2 months to 38 years) and 22.2 kg (2.7-100), respectively. The largest diameter of the defect estimated through transesophageal or transthoracic echocardiography was 4.5 mm (3 mm to 8.4 mm) while the device waist diameter was 5.5 mm (4 mm to 12 mm). The variety of the devices implanted shows the progression of the technology available during the time of the series, and the lack of devices approved for retrograde use until the arrival of the Konar-MF device.

Procedure was successful in all the patients, and immediate total occlusion was achieved in 10 patients. No acute atrioventricular block events were reported. One embolization of the ADO II device to the pulmonary artery was described in the lowest-weight patient because the defect had been initially underestimated; the defect was recaptured and closed with a larger device. Grade II tricuspid valvular disease was described in the same patient immediately after implantation.

The median x-ray image time was 15.3 min [range, 7-32]. No complications associated with arterial access were reported.

The median of follow-up after the procedure was 20 months (2-67). During this time, 3 deaths that were not associated with the procedure whatsoever (table 1). The remaining patients are still being followed without presence of atrioventricular blocks or valvular heart disease. They all keep the full closure of the defect to this date.

This is the first case series ever conducted in Spain of closure of pmVSD via retrograde arterial access with a high rate of success and a low rate of complications.

Different unspecific devices for the closure of pmVSD with symmetric design (ADO II or Piccolo) or else the new Konar-MF device (figure 1)—specifically approved for this procedure —can be implanted via retrograde arterial access, which simplifies the routine closure technique making it feasible for low-weight children in whom the creation of an arteriovenous loops is associated with a higher risk of hemodynamic instability or transient atrioventricular block. Also, the low profile of the device does not increase the risk of damage to the femoral arterial access compared to the traditional technique. Therefore, we propose this therapeutic alternative in selected patients.

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AUTHORS' CONTRIBUTIONS

A. Rasines Rodríguez, and M. M. Aristoy Zabaleta: data curation, analysis, bibliographic search, and drafting of the manuscript. C. Abelleira Pardeiro: original idea, involved with the patient healthcare process, work supervision, data curation, analysis, and drafting of the manuscript. E. J. Balbacid Domingo: work creation and supervision, and directly involved with the patient's healthcare process. S. Jiménez Valero, and F. Gutiérrez-Larraya Aguado: patient care, and critical review of the manuscript. All the authors reviewed and approved the manuscript final version.

CONFLICTS OF INTEREST

None reported.

SUPPLEMENTARY DATA

Supplementary data associated with this article can be found in the online version available at https://doi.org/10.24875/RECICE.M22000344.

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