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Short title: Explanted paravalvular leak occluders

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INTRODUCTION

Transcatheter closure of intracardiac defects has a history spanning several decades. The occluders used in this method are designed to become covered by endothelium over time, which isolates their surface from contact with blood. The duration of this process is estimated to take 3 to 6 months for occluders used in the closure of atrial septal defects [1–3]. Data on endothelialization of other intracardiac occluders are rather casuistic [4]. According to the

European Society of Cardiology guidelines, antiplatelet therapy is recommended for at least this duration [5]. However, it is noteworthy that the American College of Cardiology/American Heart Association guidelines do not specify the duration of such therapy [6]. Various therapeutic strategies are proposed for other intracardiac implants, such as occluders used for left atrial appendage closure [7] or transcatheter valve implantation [8], which typically involve at least several months of antiplatelet therapy.

Transcatheter closure of paravalvular leaks (PVLs) is an established therapeutic method, recommended in class II a under specific circumstances [8, 9]. However, there is lack of data describing the healing process of the occluders used in this method and recommendations regarding antiplatelet therapy following the procedure.

The aim of presented study was to collect data describing the process of endothelialization on explanted occluders used for transcatheter closure of PVLs.

MATERIAL AND METHODS

The study material was collected retrospectively from centers performing transcatheter closures of PVLs on surgically implanted valves. The inclusion criterion was a minimum of 30 days between occluder implantation and explantation, along with the presence of photographic documentation of the explanted occluder. The process of endothelialization was assessed visually based solely on the provided images.

RESULTS AND DISCUSSION

Data were obtained from 10 patients who had their occluders explanted in 5 referral centers. In six cases, patients required reoperation, during which the previously implanted devices were removed. In three cases, the occluders were removed percutaneously, and one device was evaluated during autopsy. The shortest duration of device retention at the implantation site was 30 days, while the longest was 2332 days. The explanted occluders represented the most commonly used types during transcatheter closure of PVLs: Occlutech Paravalvular Leak Device Occluder (PLD) and Amplatzer Valvular Plug III (AVP III). Occluders removed from paravalvular leaks around the mitral valve predominated.

A complete summary of clinical and procedural data is provided in Table 1. Visual assessment revealed that none of the occluders was fully covered by endothelium; only small islets of tissue covering a minor portion of the device were visible (Figure 1A–D). In one case, in addition to visual evaluation, histopathological analysis was obtained, which pertained to an AVP III occluder that embolized 6 months post-implantation (Figure 1E).

The collected material documents cases of incomplete endothelialization of devices implanted percutaneously for paravalvular leaks around surgically implanted heart valve prostheses, even in long-term observations. This pertains to the main types of occluders used for PVL closure; however, it may be presumed that impaired healing could affect all devices used in these procedures. The process of device neoendothelialization in humans is not well understood and data regarding possible differences between particular intracardiac locations are lacking. Currently, there is no reliable method to assess the endothelialization of intracardiac occluders in vivo. One proposed solution is angioscopic evaluation [10], which allows for the detection of areas of the occluders not covered by tissue but is unlikely to confirm complete endothelialization. A method with greater resolution is optical coherence tomography, which has been successfully used to evaluate intracardiac devices [11]. Computed tomography permits assessment of the entirety of intracardiac devices, as demonstrated in studies evaluating the healing process of left atrial appendage occluders [3], although this method has significantly lower spatial resolution compared to optical coherence tomography.

It is worth noting that a significant portion (50%) of the explanted occluders was due to persistent severe hemolysis. This underscores the necessity for meticulous closure of the leak during the procedure, particularly given the low likelihood of residual leaks diminishing in long-term follow-up [12].

The presented data cannot serve as a basis for recommending a specific anticoagulant/antiplatelet strategy following transcatheter closure of PVLs. In most cases, these patients either require chronic oral anticoagulation or antiplatelet therapy for other indications. It seems challenging to recommend escalating these therapies in this group for several months post-implantation due to the lack of a defined timeline for the healing of occluders.

CONCLUSION

Occluders implanted for paravalvular leaks around surgically implanted heart valves, especially in more complex clinical scenarios, may not undergo endothelialization in long-term follow-up. Drawing conclusions regarding recommended anticoagulant/antiplatelet therapy in this patient group requires further clinical research.

Article information

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Table 1. Explanted paravalvular leaks (PVL) occluders — summary of clinical and procedural data

No	Sex; age	Position	Valve type	Plug	Removal reason	Approach	Time to removal, days	ATT
1	M; 57	Mitral	Mech.	PLD	MHA	S	40	VKA
1’	M; 64	Aortic	Biol.	PLD	MHA, HF	S	2332	VKA
2	W; 61	Mitral	Mech.	PLD	Leaflet entrapment	S	173	VKA
3	M; 58	Mitral	Biol.	PLD	MHA	S	78	ASA
4	W; 63	Mitral	Mech.	PLD	MHA	S	61	VKA

5	M; 73	Mitral	Biol.	AVPIII	MHA	S	50	VKA +ASA
6	W; 67	Mitral	Mech.	AVPIII	Embolization	P	180	VKA
7	M; 70	Mitral	Mech.	AVPIII	HF	S	450	VKA
8	M; 70	Mitral	Mech.	PFOO	HF	S	30	VKA
9	W; 66	Mitral	Mech.	AVPIII	Leaflet entrapment	P	90	VKA
10	W; 57	Aortic	Biol.	AVPIV	MHA, HF	P	1095	ASA

Abbreviations: ASA, acetylsalicylic acid; ATT, antithrombotic therapy; AVP III, Amplatzer Vascular Plug III; AVP IV, Amplatzer Vascular Plug IV; HF, heart failure; M, man; MHA, mechanical hemolytic anemia; P, percutaneous; PLD, Occlutech Paravalvular Leak Device; S, surgical; VKA, vitamin K antagonist; W, woman

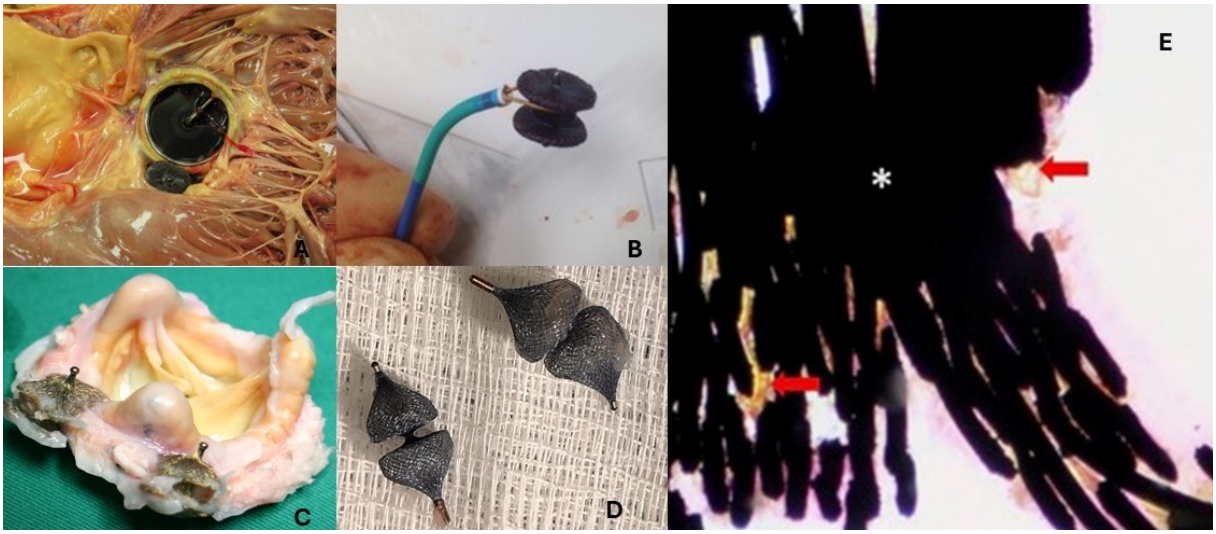

Figure 1. A series of explanted paravalvular leak occluders. Visual assessment revealed incomplete endothelialization of the devices. **A.** Case of patient with the history of mitral mechanical valve replacement and paravalvular leaks closure with the Amplatzer Vascular Plug III device explanted 15 months post-implantation. **B.** The AVP III occluder removed percutaneously 180 days after the procedure due to device embolization. **C.** Aortic bioprosthesis and Paravalvular Leak Device Occlutech occluders removed due to recurrent hemolytic anemia and heart failure symptoms after almost six years from the index procedure. **D.** Percutaneously explanted Amplatzer Vascular Plug IV device in patient with history of aortic valve replacement 3 years after the procedure. **E.** Histopathological analysis of paravalvular leak occluder

removed after 6 months due to embolization. Occluder elements (black) (*), small thrombi (arrows), hematoxylin and eosin (HE) staining, magnification 40 fold