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Usefulness of remote pulmonary arterial pressure monitoring in patients with advanced heart failure listed for HT

Utilidad de la monitorización a distancia de la presión arterial pulmonar de pacientes con insuficiencia cardiaca avanzada en lista de TxC

To the Editor,

Pulmonary hypertension (PHT) is a common finding in patients with heart failure (HF) and has prognostic relevance.[1] Increasing pulmonary congestion resulting from HF is accompanied by adaptive changes in the pulmonary circulation (remodeling of the vasculature and extracellular matrix) that lead to increased pulmonary vascular resistance (PVR) and combined precapillary and postcapillary PHT, which is frequent in patients with advanced HF.[2] Medical treatment guided by remote pulmonary arterial pressure monitoring (RPAPM) based on the wireless CardioMEMS device (Abbott, United States) implanted in the pulmonary artery reduces HF hospitalizations[3,4] and significantly decreases PHT.[5] CardioMEMS comprises the following components: a sensor with a pressure-sensitive capacitor that is placed inside a branch of the pulmonary artery using right cardiac catheterization (RCC); an electronic system that receives the pressure signal and transmits it on activation by the patient; and a software application that enables interpretation of the signal (figure 1). Readings taken via RCC in the implant help set hemodynamic targets to guide treatment.

Evaluation of PHT is a key element in pretransplant work-up. Irreversible PHT, defined as systolic pulmonary artery pressure >50 mmHg and PVR >3 Wood units or a transpulmonary gradient >15 mmHg, is considered a contraindication for isolated heart transplant. This assessment is performed using RCC and, in the case of PHT, requires the patient to initiate drug therapy to reverse the increase in PVR (diuretics, inotropic agents, or pulmonary vasodilators such as prostaglandins, phosphodiesterase 5 [PDE5] inhibitors, and endothelin receptor antagonists) or be implanted with a left ventricular assist device.[6] The hemodynamic status of patients on the transplant waiting list should be re-evaluated periodically using RCC (generally every 3-6 months). Nevertheless, given the high frequency of decompensation in these patients and the unforeseeable nature of transplant scheduling, such a strategy may be insufficient for predicting the grade of PHT at transplant, with an increase in the posttransplant risk of right-sided HF. Studies evaluating the effectiveness of RPAPM devices show that patients in New York Heart Association functional class IV are underrepresented and that transplant candidates are excluded.[3] However, RPAPM could prove useful in these patients, since it enables closer monitoring and treatment adjustment. This report aims to review preliminary experience in the use of RPAPM to guide the treatment of patients on the heart transplant waiting list.

The CardioMEMS RPAPM program at our center was started in September 2019. The system was implemented in 5 waiting list patients between November 2020 and October 2023. Pulmonary arterial pressure (PAP) readings were evaluated twice weekly by a physician from the HF unit. If the hemodynamic targets changed

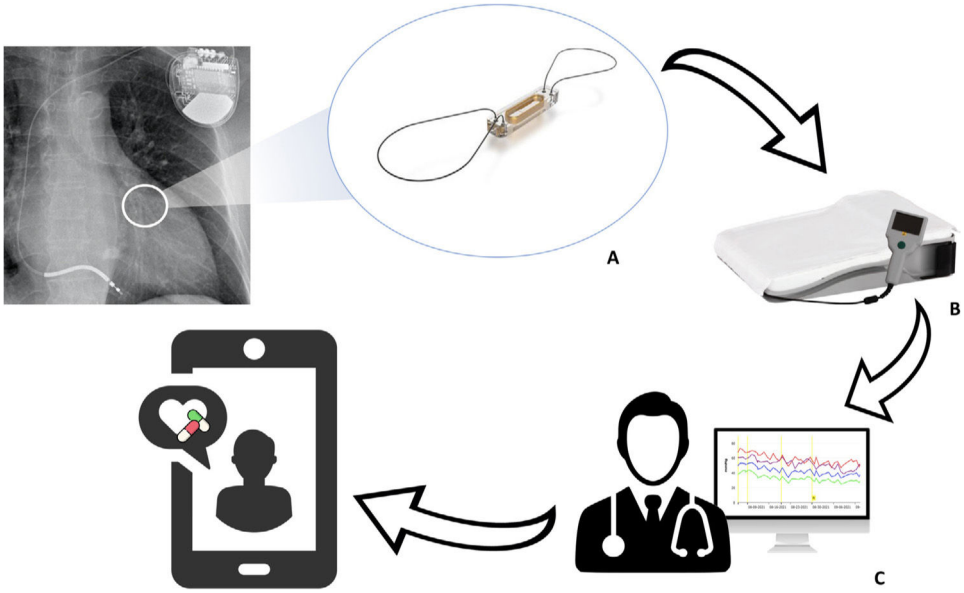

Figure 1. CardioMEMS monitoring system. A: implantable sensor. B: patient electronic system. C: computer interface of the monitoring system.

Table 1
Characteristics of patients on the heart transplant waiting list implanted with a cardiomems device

Patient	Sex	Age, y	Heart disease	LVEF, %	BMI	Status on waiting list	TPG at implantation, mmHg	DPG at implantation, mmHg	PAPd at implantation, mmHg	Time between implantation and transplant, d	Transplant status	PAPd at transplantation, mmHg	PGF	Alive 30 d after transplant	Posttransplant PAPd, mmHg
1	Male	65	Hypertrophic cardiomyopathy	50	31	Transplanted	12	5	31	126	Urgent	21	Yes	Yes	11
2	Male	67	Hypertrophic cardiomyopathy	18	25.5	Transplanted	10	3	21	76	Urgent	20	No	Yes	—
3	Male	59	Amyloidosis	61	34.7	Temporarily delisted	15	5	21	—	—	—	—	—	—
4	Male	63	Dilated cardiomyopathy	17	23.6	Transplanted	11	7	36	61	Elective	31	No	Yes	18
5	Female	59	Valvular	32	31.1	Temporarily delisted + early relisting	12	3	21	—	—	—	—	—	—

BMI, body mass index; DPG, diastolic pulmonary gradient; LVEF, left ventricular ejection fraction; PAPd, diastolic pulmonary arterial pressure; PGF, primary graft failure; TPG, transpulmonary gradient.

significantly, eg, increases of 3 to 5 mmHg in diastolic pulmonary arterial pressure (PAPd) for 5 days or 5 mmHg in 1 day, the patient was contacted to adjust treatment or given an appointment for intravenous treatment or admission to hospital. If PAP did not improve, RCC was repeated to re-evaluate PVR and the patient's suitability for transplant. In addition, all patients were evaluated in person at least every 4 to 6 weeks.

Patient characteristics are summarized in table 1. The patients selected for RPAPM were those who required specific medical treatment to revert PVR (inotropic drugs and PDE5 inhibitors) in the RCC during the pretransplant work-up or those with significantly elevated filling pressure in the follow-up RCCs while on the waiting list and who required intravenous treatment.

During a median [interquartile range] follow-up of 75 [70-125] days, 3 patients received a transplant and 2 were temporarily delisted owing to a significant increase in PAP confirmed by RCC at 3 months and at 3 weeks after inclusion. One of the delisted patients was relisted 20 days after hemodynamic optimization with intravenous diuretics and PDE5 inhibitors. Due to the underlying heart disease, none of the patients were considered candidates for a left ventricular assist device.

Two of the transplants were urgent procedures (status 0) with an Impella CP device (Abiomed, United States), and the other was elective. Following the transplant, 1 patient developed right-sided HF requiring implantation of a centrifugal right ventricular assist device immediately after surgery; no complications were detected in the other 2 patients. All 3 patients were discharged.

The median time with RPAPM before transplant was 76 [61-76] days. During this period, treatment was adjusted 4 times for each patient, mainly temporary increases in the oral diuretics dose, although on 4 occasions intravenous treatment was required (diuretics or inotropic drugs [levosimendan]). PAPd values decreased significantly in all patients between implantation and transplant (median, 5 [1-5] mmHg). CardioMEMS readings continued to be taken in 2 patients after transplant, revealing a marked reduction in PAPd (table 1).

The results recorded show the usefulness and safety of RPAPM with implantable devices in selected patients at high risk of worsening PHT while on the transplant waiting list. At the time of their transplant, patients had significantly decreased PHT, and none had experienced implant-related adverse events. Moreover, RPAPM enabled the detection of significant variations in PAP in patients on the waiting list and guided repeat RCC to determine the patient's suitability for transplantation earlier than specified in the protocol. However, various questions remain to be elucidated, such as the most suitable posttransplantation antithrombotic treatment for patients on the waiting list and research lines of interest, including the usefulness of RPAPM in the posttransplant follow-up of these patients.

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ETHICAL CONSIDERATIONS

The authors state that the content of the present study did not require specific approval by their institution's Clinical Research Ethics Committee. All study patients gave their written informed consent to be included on the heart transplant waiting list and to

be implanted with the CardioMEMS remote pulmonary arterial pressure device.

The male-to-female ratio in the present study was 4:1, reflecting the real-world situation of heart transplant in Spain and elsewhere.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

Artificial intelligence was not used in the preparation of the present study.

AUTHORS' CONTRIBUTIONS

All authors participated in this research, evaluated the results, and agree to their publication.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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Initial experience with a circulatory support program in massive pulmonary thromboembolism

Experiencia inicial de un programa de soporte circulatorio en tromboembolia pulmonar masiva

To the Editor,

Acute pulmonary embolism (PE) is the third leading cause of cardiovascular mortality. In Spain, it has an annual incidence of 154 cases per 100 000 inhabitants.[1] The mortality rate for massive PE (cardiogenic shock, systolic blood pressure < 90 mmHg, and organ hypoperfusion) can be as high as 60%. Catheter-directed therapy is an alternative to systemic fibrinolysis in refractory cases or patients with a high risk of bleeding.

A recent study of catheter-directed therapy in patients with high-risk PE reported a success rate of 80% and a complication rate of less than 5%.[2] Extracorporeal cardiopulmonary resuscitation (CPR) consists of the rapid deployment of venoarterial extracorporeal membrane oxygenation (VA-ECMO) to provide circulatory support when conventional CPR fails to achieve sustained return of spontaneous circulation. Clinical practice guidelines recommend considering VA-ECMO as rescue therapy for selected patients. In patients with massive PE who develop refractory cardiogenic shock or experience cardiorespiratory arrest, VA-ECMO can be used to maintain appropriate hemodynamics and organ perfusion, serving as a bridge to stabilization or reperfusion.

We describe our initial experience with percutaneous mechanical thrombectomy and VA-ECMO. Cannulation was performed by a specialist cardiovascular technologist and an ECMO-experienced intensivist in the catheterization laboratory using arterial return cannulas (17-19 Fr) and venous drainage cannulas (21-25 Fr) (BioMedicus NextGen; Medtronic, United States). The Novalung ECMO circuit (Fresenius, United States) was primed. Vascular access was achieved percutaneously under ultrasound guidance with fluoroscopic confirmation using a unilateral or bilateral femorofemoral approach. In all cases, a 6-Fr distal perfusion cannula was placed in the superficial femoral artery. After initiation of VA-ECMO (flow rate of 3-4 L/min), thrombectomy was performed via the femoral vein contralateral to the venous drainage cannula. A 24-Fr Gore DrySeal Flex introducer sheath (Gore Medical, United States) and the FlowTriever 24 Curve system (Inari Medical, United States) were used to maximize aspiration. ECMO support was interrupted momentarily during the removal of the 24-Fr introducer sheath to prevent air from entering the system. Although the ECMO system is designed to eliminate this risk, a large volume of air entering the system could disrupt the flow of blood through the centrifugal pump, compromising life support. Vascular closure was achieved using compression and figure-of-8 sutures. The patients were transferred to the coronary care unit on completion of the thrombectomy.

In 2023, we performed 4 mechanical thrombectomies with VA-ECMO: 2 in patients with cardiorespiratory arrest and 2 in patients with refractory cardiogenic shock in whom fibrinolysis had been ineffective. The cases were diagnosed by transthoracic echocardiography and confirmed by angiography after initiation of ECMO. Support was started within 4 hours of diagnosis in all cases. All patients received norepinephrine at a dosage of > 1 μg/kg/min. The mean patient age was 51 years (table 1). The median