

CATETERISMO CARDÍACO NA AVALIAÇÃO HEMODINÂMICA E NO MANEJO DA INSUFICIÊNCIA CARDÍACA AVANÇADA

CARDIAC CATHETERIZATION IN HEMODYNAMIC ASSESSMENT AND MANAGEMENT OF ADVANCED HEART FAILURE

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Eixo Temático: Saúde

RESUMO

A insuficiência cardíaca é uma síndrome clínica caracterizada pela incapacidade do coração de atender adequadamente às demandas circulatórias do organismo, podendo resultar de diferentes condições cardiovasculares, incluindo hipertensão arterial sistêmica, doença arterial coronariana e alterações valvares. A avaliação hemodinâmica apresenta especial importância em pacientes com doença avançada, sintomas persistentes, hipertensão pulmonar, choque cardiogênico ou que estejam sendo considerados para terapias avançadas. Nesse contexto, o cateterismo cardíaco, especialmente o cateterismo cardíaco direito, permite a mensuração direta de importantes parâmetros hemodinâmicos e pode contribuir para decisões diagnósticas, prognósticas e terapêuticas. Este estudo teve como objetivo analisar a importância do cateterismo cardíaco na avaliação e no manejo de pacientes com insuficiência cardíaca, com ênfase na avaliação hemodinâmica, na hipertensão pulmonar e nas terapias avançadas, incluindo o suporte circulatório mecânico. Foi realizada uma revisão de literatura de caráter descritivo, baseada em dois estudos selecionados relacionados à avaliação hemodinâmica invasiva na insuficiência cardíaca. A análise demonstrou que o cateterismo cardíaco direito fornece informações relevantes sobre as pressões de enchimento cardíaco, pressões pulmonares, débito cardíaco e resistência vascular, contribuindo para a avaliação da insuficiência cardíaca avançada, do choque cardiogênico, da hipertensão pulmonar e de pacientes em avaliação para transplante cardíaco ou terapia com dispositivos de assistência ventricular esquerda. Além disso, a associação do cateterismo cardíaco direito e esquerdo durante estudos de rampa em pacientes com dispositivos de assistência ventricular esquerda forneceu informações adicionais para a otimização do suporte mecânico e para a identificação de complicações, como trombose do dispositivo e insuficiência aórtica. Dessa forma, o cateterismo cardíaco constitui uma ferramenta importante para a avaliação hemodinâmica individualizada e para a tomada de decisões clínicas em pacientes selecionados com insuficiência cardíaca, especialmente aqueles com doença avançada e necessidade de suporte circulatório mecânico.

Palavras-chave: Insuficiência Cardíaca; Cateterismo Cardíaco; Avaliação Hemodinâmica; Hipertensão Pulmonar; Suporte Circulatório Mecânico.

ABSTRACT

Heart failure is a clinical syndrome characterized by the heart's inability to adequately meet the body's circulatory demands and may result from several cardiovascular conditions, including systemic arterial hypertension, coronary artery disease, and valvular disorders. Hemodynamic assessment is particularly important in patients with advanced disease, persistent symptoms, pulmonary hypertension, cardiogenic shock, or those being considered for advanced therapies. In this context, cardiac catheterization, especially right heart catheterization, provides direct measurements of important hemodynamic parameters and may contribute to diagnostic, prognostic, and therapeutic decision-making. This study aimed to analyze the importance of cardiac catheterization in the evaluation and management of patients with heart failure, with emphasis on hemodynamic assessment, pulmonary hypertension, and advanced therapies, including mechanical circulatory support. A descriptive literature review was conducted based on two selected studies addressing invasive hemodynamic assessment in heart failure. The analysis demonstrated that right heart catheterization provides relevant

information regarding cardiac filling pressures, pulmonary pressures, cardiac output, and vascular resistance, contributing to the assessment of advanced heart failure, cardiogenic shock, pulmonary hypertension, and patients undergoing evaluation for heart transplantation or LVAD therapy. Additionally, combined right and left heart catheterization during LVAD ramp studies provided additional information for device optimization and identification of complications such as device thrombosis and aortic insufficiency. Therefore, cardiac catheterization represents an important tool for individualized hemodynamic assessment and clinical decision-making in selected patients with heart failure, particularly those with advanced disease and requiring mechanical circulatory support.

Keywords: Heart Failure; Cardiac Catheterization; Hemodynamic Assessment; Pulmonary Hypertension; Mechanical Circulatory Support.

INTRODUÇÃO

Heart failure (HF) is a clinical syndrome characterized by the heart's inability to pump blood adequately to meet the body's needs. This condition can result from several cardiovascular diseases, such as systemic arterial hypertension, coronary artery disease, and valvular disorders, as well as other conditions that impair cardiac structure or function. As a consequence of the heart's reduced ability to maintain adequate cardiac output, the body may experience impaired oxygen and nutrient delivery to tissues, as well as changes in cardiac filling pressures. These alterations may result in clinical manifestations such as dyspnea, fatigue, weakness, edema, and reduced ability to perform activities that were previously well tolerated. The intensity and presentation of these symptoms may vary according to disease severity and the extent of cardiac dysfunction.

Heart failure can present with different mechanisms and degrees of severity, affecting both the heart's ability to contract and its ability to relax. Therefore, assessing the patient's hemodynamic status is important for understanding cardiac function and identifying abnormalities that may be associated with the symptoms presented. Although noninvasive methods are widely used in the evaluation of these patients, some clinical situations require a more precise characterization of hemodynamic conditions, particularly in individuals with advanced heart failure, persistent symptoms, or suspected abnormalities in cardiac and pulmonary pressures. In this context, invasive hemodynamic assessment can provide important complementary information for clinical management.¹

Right heart catheterization is an important tool for hemodynamic assessment in patients with heart failure, as it allows direct measurement of parameters such as cardiac filling pressures, pulmonary artery pressure, cardiac output, and pulmonary vascular resistance. These measurements can assist in the identification and assessment of the severity of pulmonary hypertension, as well as in understanding the patient's hemodynamic status. In addition, the procedure is particularly relevant in more complex clinical situations and may contribute to the evaluation of patients with advanced heart failure and to decision-making regarding advanced therapies, such as heart transplantation and the use of mechanical circulatory support devices.¹

In patients receiving left ventricular assist devices, invasive hemodynamic assessment may also play an important role in evaluating the cardiac response to mechanical support. In these cases, protocols combining catheterization with different levels of device support allow changes in cardiac pressures to be assessed and the adequacy of circulatory support to be evaluated. Thus, catheterization may contribute not only to the characterization of hemodynamic conditions but also to optimization of device function and identification of potential treatment-related abnormalities, such as device thrombosis or aortic regurgitation.²

Given the relevance of hemodynamic assessment in heart failure and the use of cardiac catheterization in more complex clinical situations, this study aimed to analyze the importance of cardiac catheterization in the evaluation and management of patients with heart failure, highlighting its contribution to hemodynamic characterization, assessment of pulmonary hypertension, and management of advanced therapies, including mechanical circulatory support.

MÉTODO

A descriptive literature review was conducted with the aim of gathering information regarding the use of cardiac catheterization in the hemodynamic assessment and management of patients with heart failure. The studies were selected from scientific articles identified in the PubMed database, considering their direct relevance to the proposed topic and their contribution to the understanding of invasive hemodynamic assessment in heart failure.

Two articles were selected for analysis. The first, published by Rajagopalan et al. in 2024, addresses hemodynamic assessment through right heart catheterization in patients with heart failure, highlighting its diagnostic and therapeutic applications. The second, published by Rosenbaum et al. in 2019, addresses the use of a left heart catheterization protocol associated with hemodynamic assessment in patients receiving left ventricular assist devices, focusing on the optimization of mechanical circulatory support.

The studies were analyzed descriptively and comparatively, considering the main aspects related to the indications for cardiac catheterization, the hemodynamic parameters assessed, and its contribution to the management of patients with heart failure, particularly those with advanced disease and those receiving mechanical circulatory support.

RESULTADOS

The analysis of the selected studies demonstrated the importance of invasive hemodynamic assessment in the evaluation and management of patients with heart failure, particularly in more complex clinical situations. In the review by Rajagopalan et al.¹, right heart catheterization (RHC) was presented as an important tool for hemodynamic assessment throughout the spectrum of heart failure, ranging from ambulatory patients to those with cardiogenic shock and patients being considered for advanced therapies. The procedure allows direct assessment of parameters such as right atrial pressure, pulmonary artery pressure, pulmonary capillary wedge pressure, cardiac output, and pulmonary and systemic vascular resistance, providing a more comprehensive characterization of the patient's hemodynamic status.¹

Among the main findings described by Rajagopalan et al.¹ was the usefulness of RHC in patients with advanced heart failure, refractory symptoms, or clinical conditions in which the cause of symptoms or the hemodynamic status remains unclear. In these situations, invasive assessment can provide information that may be difficult to obtain accurately through physical examination, laboratory testing, and noninvasive imaging. RHC can also assist in the identification and characterization of pulmonary hypertension and in the assessment of changes in hemodynamic parameters during exercise.¹

The review also highlighted the importance of invasive hemodynamic assessment in patients with cardiogenic shock. Several hemodynamic parameters were associated with disease severity and mortality, particularly markers of right ventricular dysfunction. Elevated right atrial pressure, an increased right atrial pressure-to-pulmonary capillary wedge pressure ratio, reduced pulmonary artery pulsatility index, and reduced right ventricular cardiac power output were associated with worse outcomes in patients with cardiogenic shock. These findings demonstrate the potential value of invasive hemodynamic measurements in recognizing clinical deterioration and assessing prognosis.¹

In addition, RHC was shown to have an important role in the evaluation of patients with advanced heart failure who may require advanced therapies. Hemodynamic measurements can contribute to the assessment and prioritization of candidates for heart transplantation and to the evaluation of patients considered for left ventricular assist device (LVAD) therapy. The assessment of pulmonary pressures and vascular resistance is particularly relevant in this context, as these parameters may influence therapeutic decisions and the risk associated with advanced interventions.¹

The second study, conducted by Rosenbaum et al.², complemented these findings by evaluating a novel left heart catheterization protocol combined with right heart catheterization during a hemodynamic ramp study in patients supported by continuous-flow LVADs. Thirty-eight patients were evaluated at a median of 446 days after device implantation. During the procedure, continuous aortic and left ventricular pressures were measured together with right atrial pressure, pulmonary artery pressure, and pulmonary capillary wedge pressure. The authors established the transaortic gradient (TAG) as a novel hemodynamic parameter to provide additional information for LVAD optimization.²

During the ramp study, reductions in left ventricular end-diastolic pressure and pulmonary capillary wedge pressure were associated with an increase in TAG. A TAG range of 20–40 mmHg was identified as providing the most optimal level of hemodynamic left ventricular unloading. Values above 40 mmHg were associated with reductions in right ventricular stroke work index and pulmonary artery pulsatility index, suggesting that excessive LVAD speed may negatively affect right ventricular function.²

The study also demonstrated that pathological conditions produced distinct hemodynamic responses during the ramp protocol. Patients with LVAD thrombosis showed an inability to appropriately increase TAG with increasing device speed. In contrast, patients with significant aortic insufficiency demonstrated a marked increase in left ventricular end-diastolic pressure despite a simultaneous decrease in pulmonary capillary wedge pressure as LVAD speed increased. These findings indicate that the addition of left heart catheterization to the conventional right heart catheterization ramp protocol can provide additional information for identifying pathological conditions and optimizing LVAD support.²

Overall, the findings from both studies demonstrate that cardiac catheterization provides relevant information for the hemodynamic characterization of patients with heart failure. While Rajagopalan et al.¹ emphasized the role of RHC in diagnosis, prognosis, assessment of pulmonary hypertension, cardiogenic shock, and advanced heart failure, Rosenbaum et al.² demonstrated the additional value of combined right and left heart catheterization for the optimization of mechanical circulatory support and identification of complications in patients receiving LVAD therapy.

CONCLUSÃO

The analysis of the selected studies demonstrated that cardiac catheterization plays an important role in the hemodynamic assessment and management of patients with heart failure, particularly in more complex clinical situations. Right heart catheterization provides essential information regarding cardiac filling pressures, pulmonary pressures, cardiac output, and vascular resistance, contributing to the assessment of pulmonary hypertension, advanced heart failure, cardiogenic shock, and patients being considered for heart transplantation or mechanical circulatory support.

Furthermore, the findings of Rosenbaum et al.² demonstrated that the combination of right and left heart catheterization can provide additional information for the optimization of LVAD therapy and the identification of device-related complications. Therefore, invasive hemodynamic assessment represents an important tool for individualized clinical decision-making in selected patients with heart failure, particularly those with advanced disease and requiring mechanical circulatory support.

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