

Tachycardiomyopathies

Luís Beck-da-Silva^{1,2}  and Andreia Biolo^{1,2} 

Departamento de Medicina Interna da Universidade Federal do Rio Grande do Sul (UFRGS),¹ Porto Alegre, RS – Brazil

Serviço de Cardiologia do Hospital de Clínicas de Porto Alegre (HCPA),² Porto Alegre, RS – Brazil

What are tachycardiomyopathies?

Tachycardiomyopathy is a relatively uncommon heart condition in which the myocardium develops ventricular dysfunction as a consequence of a persistently abnormal heart rhythm. One of the characteristics of this condition is that it is partially or completely reversible, once the arrhythmia has been controlled, making it crucial to recognize adequately in order to make recovery of ventricular function possible.¹ In fact, the term “arrhythmia-induced cardiomyopathy” has emerged because tachycardiomyopathy results not only from prolonged and uncontrolled atrial or ventricular tachycardia, but also from atrial and/or ventricular ectopy leading to dyssynchrony.² Both conditions can lead to chronic myocardial overload, resulting in ventricular dysfunction and heart failure.

Tachycardiomyopathies can be classified into two groups: in the first, arrhythmia is the only identified cause of ventricular dysfunction (arrhythmia-induced); in the second, the arrhythmia may aggravate ventricular dysfunction or worsen heart failure in a patient with pre-existing heart disease (arrhythmia-mediated).

The prevalence and incidence of tachycardiomyopathy are not very well known, and it is believed that this condition is still underrecognized. The incidence of tachycardiomyopathy in patients with atrial tachycardias is around 8% to 10%. In patients with frequent ventricular extrasystoles and/or non-sustained ventricular tachycardia, it can reach more than 30%. Regarding atrial fibrillation, its relationship with heart failure is complex. Up to 50% of patients with heart failure have atrial fibrillation and may have worsened symptoms and ventricular function due to the arrhythmia itself and/or to poorly controlled ventricular response; it is believed that approximately 40% of patients with either heart failure or atrial fibrillation will develop the other condition.³ As tachycardiomyopathy is properly recognized, its prevalence as a cause of heart failure increases, reaching 9% of cases.⁴

When should we consider tachycardiomyopathy as an etiology of heart failure and how should we diagnose it?

There are no established diagnostic criteria for tachycardiomyopathy, but early diagnosis is essential for

greater potential recovery with appropriate treatment. Accordingly, suspicion should begin with clinical presentation in patients with heart failure or new ventricular dysfunction and chronic or recurrent tachycardia, or with the identification of frequent ventricular extrasystoles.^{1,5} In this condition, the diagnosis of tachycardiomyopathy can be reinforced by the following findings:

- exclusion of other identified obvious causes (ischemic, hypertensive, valvular, or toxic heart disease, among others) or dysfunction disproportionate to that resulting from these comorbidities;
- absence of significant structural alterations (marked ventricular hypertrophy and dilation);
- recovery of ventricular function after arrhythmia control (generally within 1 to 6 months) and/or worsening of ventricular function after recurrence of previously controlled arrhythmia;
- prior record of preserved ventricular function may further reinforce the diagnosis.

There is no known precise heart rate that results in tachycardiomyopathy, but it is believed that chronic tachycardia (>100 beats per minute) that occurs during more than 10% to 15% of the day can result in tachycardiomyopathy. Furthermore, resting heart rate may not be a good indicator of mean heart rate, and prolonged monitoring (with 24-hour Holter, for example) is very important for this diagnosis.

Another important issue is the recognition of arrhythmia-mediated tachycardiomyopathy, where the patient may have previous ventricular dysfunction and deteriorate due to the arrhythmia. These conditions can be challenging, and complementary tests, such as cardiac magnetic resonance imaging, play a very important role in these scenarios. Cardiac magnetic resonance can help identify the etiology of heart failure and unrecognized structural disease; moreover, findings such as the presence of delayed enhancement can also assist evaluation of prognosis and the likelihood of recovering ventricular function after intervention, such as ablative therapies.⁶ Accordingly, marked clinical improvement and a decrease in natriuretic peptides are also indicative of tachycardiomyopathy, rather than the presence of non-reversible cardiomyopathies. Specifically regarding natriuretic peptides, reductions 1 or 4 weeks after cardioversion seem to differentiate patients with tachycardiomyopathy from those with structural heart disease.⁷

Therefore, various elements are necessary for the proper diagnosis of tachycardiomyopathy, including attention to clinical presentation, active search for arrhythmias, use of complementary tests to characterize the structural phenotype, and evaluation of response to therapies. Attention and early identification are crucial to adequate therapeutic approach and better recovery from ventricular dysfunction.

Keywords

Tachycardiomyopathy; Arrhythmia; Atrial Fibrillation; Supraventricular Tachycardia; Heart Failure.

Mailing Address: Luís Beck-da-Silva e Andreia Biolo •

Serviço de Cardiologia, Hospital de Clínicas de Porto Alegre (HCPA) – Rua Ramiro Barcelos, 2350. Postal Code 90035-003, Porto Alegre, RS – Brasil
E-mail: lbneto@hcpa.edu.br, abiolo@hcpa.edu.br

Manuscript received May 16, 2023, revised manuscript May 25, 2023, accepted May 25, 2023

DOI: <https://doi.org/10.36660/abchf.20230044>

Treatment

Treatment of tachycardiomyopathy involves both controlling heart rate and treating the underlying cause of the tachycardia. Therapeutic options for tachycardiomyopathy include the following.

Heart rate control

The goal is to keep the heart rate within a normal range in order to reduce the load on the heart. This can be achieved through medications such as beta blockers, calcium channel blockers, or digoxin. Clinical management of tachycardiomyopathy may differ depending on the rhythm causing the tachycardia (Figure 1). The rhythms frequently associated with tachycardiomyopathies are atrial fibrillation, supraventricular tachycardias, and ventricular extrasystoles.

Atrial fibrillation

In atrial fibrillation, heart rate can be controlled pharmacologically or reverted to sinus rhythm. These two strategies, rhythm control versus rate control, were duly compared in a randomized, multicenter clinical trial with more than 4000 patients, which showed that the strategy of rhythm control did not promote a survival advantage in relation to rate control, and there was a lower risk of adverse drug effects with the strategy of rate control.⁸ When this study design was repeated in a population of patients with heart failure with reduced ejection fraction (HFrEF), in the AF-CHF Trial, the findings were superimposable on the findings in patients without HFrEF.⁹ The main medications used to control the frequency of patients with HFrEF were beta blockers and digoxin.⁹ In contrast to the studies in which rhythm control was based on electrical cardioversion, the CASTLE-HF study provided evidence that, when patients with atrial fibrillation and HFrEF were treated with atrial fibrillation ablation, the result was a 47% reduction in overall 5-year mortality.¹⁰ The CABANA clinical trial failed to demonstrate a benefit on mortality alone, but demonstrated a benefit on the composite endpoint of mortality and cardiovascular hospitalization of approximately 17%.¹¹ Subsequently, a meta-analysis of 6 randomized clinical trials, including data from the CASTLE-HF, concluded that catheter ablation is superior to medical treatment for atrial fibrillation in patients with heart failure, resulting in improved left ventricular ejection fraction, quality of life, functional status, and survival.¹² Atrial fibrillation ablation by pulmonary-vein isolation was compared to the alternative of atrioventricular-node ablation with pacemaker implantation in a study including 41 patients with HFrEF and symptomatic, drug resistant atrial fibrillation. Atrial fibrillation ablation was superior in intermediate outcomes, such as improved ejection fraction and 6-minute walk test.¹³

Supraventricular tachycardias

Incessant atrial tachycardias can lead to tachycardiomyopathy in up to 10% of cases. Case series of patients undergoing radiofrequency ablation of the focus of atrial arrhythmia have demonstrated that, after successful ablation, left ventricular

function was restored in 97% of patients within a mean of 3 months.^{14,15}

Ventricular extrasystoles

Burden of ventricular extrasystoles is a predictor of tachycardiomyopathy. It is considered relevant if > 10% of ventricular extrasystoles/day or > 10,000 ventricular extrasystoles/day. Elimination of marked burdens of ventricular extrasystoles with ablation results in structural recovery of the left ventricle¹⁶ and improves the effectiveness of cardiac resynchronization therapy in non-responders.¹⁷ The medications most commonly used to reduce the burden of ventricular extrasystoles in patients with tachycardiomyopathy are beta blockers, preferably those approved for the treatment of heart failure, such as amiodarone and sotalol.

Treatment of the underlying cause

It is important to treat the underlying cause of the tachycardia, which may include correcting a hormonal disorder, removing a tumor, or treating a psychological disorder. Heart rate control can often be facilitated, or the effects of an arrhythmia can be minimized by appropriately treating heart failure, if present. Sometimes surgical intervention is needed to correct the underlying cause of the tachycardia.

Supportive treatment

In severe cases, hospitalization for supportive care may be necessary. This may include oxygen, diuretics, and careful monitoring of heart function. In very severe cases, mechanical circulatory assistance (such as an intra-aortic balloon pump or extracorporeal membrane oxygenation) or even heart transplantation may be necessary.

Prognosis

The prognosis of patients with tachycardiomyopathy may depend on multiple factors. It certainly depends on the underlying cause of the tachycardia, the duration of the tachycardia, and the consequent degree of ventricular function impairment, in addition to factors such as the patient's age and comorbidities.

If tachycardiomyopathy is diagnosed and treated early, and if the cause of ventricular dysfunction is indeed tachycardia, prognosis is generally favorable, with significant recovery of ventricular function, improved symptoms, and reduced risk of disease progression.^{3,18} In cases where ventricular function does not improve after correction of tachycardia, the diagnosis of tachycardiomyopathy is questioned.

On the other hand, if tachycardiomyopathy is left untreated, it can lead to the progression of heart failure, with all its repercussions.

Conclusion

The possible treatments and the potential reversibility make tachycardiomyopathy a diagnosis that must be pursued, and

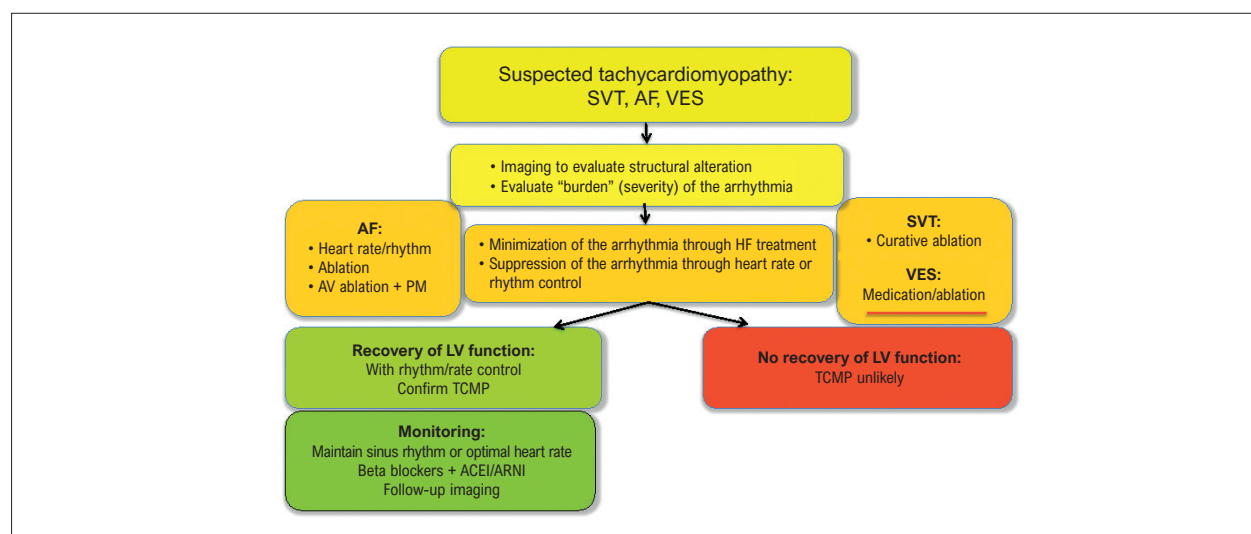


Figure 1 – Flowchart for management of tachycardiomyopathies. ACEI: angiotensin-converting enzyme inhibitor; AF: atrial fibrillation; ARNI: angiotensin receptor-neprilysin inhibitor; AV: atrioventricular; HF: heart failure; HR: heart rate; LV: left ventricular; PM: pacemaker; SVT: supraventricular tachycardia; TCMP: tachycardiomyopathy; VES: ventricular extrasystole.

tachycardia is a relevant therapeutic target with potential benefits regarding the natural history of the disease.

Author Contributions

Writing of the manuscript and Critical revision of the manuscript for important intellectual content: Beck-da-Silva L, Biolo A.

Potential conflict of interest

No potential conflict of interest relevant to this article was reported.

Sources of funding

There were no external funding sources for this study.

Study association

This study is not associated with any thesis or dissertation work.

Ethics approval and consent to participate

This article does not contain any studies with human participants or animals performed by any of the authors.

References

- Martin CA, Lambiase PD. Pathophysiology, Diagnosis and Treatment of Tachycardiomyopathy. *Heart*. 2017;103(19):1543-52. doi: 10.1136/heartjnl-2016-310391.
- Copinathannair R, Etheridge SP, Marchlinski FE, Spinale FG, Lakkireddy D, Olshansky B. Arrhythmia-Induced Cardiomyopathies: Mechanisms, Recognition, and Management. *J Am Coll Cardiol*. 2015;66(15):1714-28. doi: 10.1016/j.jacc.2015.08.038.
- Manolis AS, Manolis TA, Manolis AA, Melita H. Atrial Fibrillation-Induced Tachycardiomyopathy and Heart Failure: An Underappreciated and Elusive Condition. *Heart Fail Rev*. 2022;27(6):2119-35. doi: 10.1007/s10741-022-10221-1.
- Stronati G, Guerra F, Urbinati A, Ciliberti G, Cipolletta L, Capucci A. Tachycardiomyopathy in Patients without Underlying Structural Heart Disease. *J Clin Med*. 2019;8(9):1411. doi: 10.3390/jcm8091411.
- Gupta S, Figueredo VM. Tachycardia Mediated Cardiomyopathy: Pathophysiology, Mechanisms, Clinical Features and Management. *Int J Cardiol*. 2014;172(1):40-6. doi: 10.1016/j.ijcard.2013.12.180.
- Addison D, Farhad H, Shah RV, Mayrhofer T, Abbasi SA, John RM, et al. Effect of Late Gadolinium Enhancement on the Recovery of Left Ventricular Systolic Function After Pulmonary Vein Isolation. *J Am Heart Assoc*. 2016;5(9):e003570. doi: 10.1161/JAHA.116.003570.
- Nia AM, Gassanov N, Dahlem KM, Caglayan E, Hellmich M, Erdmann E, et al. Diagnostic Accuracy of NT-proBNP Ratio (BNP-R) for Early Diagnosis of Tachycardia-Mediated Cardiomyopathy: A Pilot Study. *Clin Res Cardiol*. 2011;100(10):887-96. doi: 10.1007/s00392-011-0319-y.
- Wyse DG, Waldo AL, DiMarco JP, Domanski MJ, Rosenberg Y, Schron EB, et al. A Comparison of Rate Control and Rhythm Control in Patients with Atrial Fibrillation. *N Engl J Med*. 2002;347(23):1825-33. doi: 10.1056/NEJMoa021328.
- Roy D, Talajic M, Nattel S, Wyse DG, Dorian P, Lee KL, et al. Rhythm Control versus Rate Control for Atrial Fibrillation and Heart Failure. *N Engl J Med*. 2008;358(25):2667-77. doi: 10.1056/NEJMoa0708789.
- Marrouche NF, Brachmann J, Andresen D, Siebels J, Boersma L, Jordaens L, et al. Catheter Ablation for Atrial Fibrillation with Heart Failure. *N Engl J Med*. 2018;378(5):417-27. doi: 10.1056/NEJMoa1707855.
- Packer DL, Mark DB, Robb RA, Monahan KH, Bahnsen TD, Poole JE, et al. Effect of Catheter Ablation vs Antiarrhythmic Drug Therapy on Mortality, Stroke, Bleeding, and Cardiac Arrest Among Patients With Atrial Fibrillation: The CABANA Randomized Clinical Trial. *JAMA*. 2019;321(13):1261-74. doi: 10.1001/jama.2019.0693.

12. Virk SA, Bennett RG, Chow C, Sanders P, Kalman JM, Thomas S, et al. Catheter Ablation versus Medical Therapy for Atrial Fibrillation in Patients With Heart Failure: A Meta-Analysis of Randomised Controlled Trials. *Heart Lung Circ.* 2019;28(5):707-18. doi: 10.1016/j.hlc.2018.10.022.
13. Khan MN, Jaïs P, Cummings J, Di Biase L, Sanders P, Martin DO, et al. Pulmonary-Vein Isolation for Atrial Fibrillation in Patients with Heart Failure. *N Engl J Med.* 2008;359(17):1778-85. doi: 10.1056/NEJMoa0708234.
14. Medi C, Kalman JM, Haqqani H, Vohra JK, Morton JB, Sparks PB, et al. Tachycardia-Mediated Cardiomyopathy Secondary to Focal Atrial Tachycardia: Long-Term Outcome after Catheter Ablation. *J Am Coll Cardiol.* 2009;53(19):1791-7. doi: 10.1016/j.jacc.2009.02.014.
15. Cruz FE, Cheriex EC, Smeets JL, Atié J, Peres AK, Penn OC, et al. Reversibility of Tachycardia-Induced Cardiomyopathy after Cure of Incessant Supraventricular Tachycardia. *J Am Coll Cardiol.* 1990;16(3):739-44. doi: 10.1016/0735-1097(90)90368-y.
16. Bogun F, Crawford T, Reich S, Koelling TM, Armstrong W, Good E, et al. Radiofrequency Ablation of Frequent, Idiopathic Premature Ventricular Complexes: Comparison with a Control Group without interVention. *Heart Rhythm.* 2007;4(7):863-7. doi: 10.1016/j.hrthm.2007.03.003.
17. Lakkireddy D, Di Biase L, Ryschon K, Biria M, Swarup V, Reddy YM, et al. Radiofrequency Ablation of Premature Ventricular Ectopy Improves the Efficacy of Cardiac Resynchronization Therapy in Nonresponders. *J Am Coll Cardiol.* 2012;60(16):1531-9. doi: 10.1016/j.jacc.2012.06.035.
18. Brembilla-Perrot B, Ferreira JP, Manenti V, Sellal JM, Olivier A, Villemin T, et al. Predictors and Prognostic Significance of Tachycardiomyopathy: Insights from a Cohort of 1269 Patients Undergoing atrial Flutter Ablation. *Eur J Heart Fail.* 2016;18(4):394-401. doi: 10.1002/ejhf.482.



This is an open-access article distributed under the terms of the Creative Commons Attribution License