Some Myocardial Morphologic Changes Induced by Anorexia Nervosa.
The Role of Echocardiography

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Abstract

Background: Anorexia Nervosa (AN) is a frequent eating disorder, responsible for several cardiovascular and extravascular complications.

Methods: We considered some morphological complications of left ventricle (LV) only, due to long-standing AN, such as pericardial effusion, mitral valve prolapse, some cardiomyopathies. These complications were usually seen with conventional 2D-echocardiography and recently, with ultrasonic techniques, such as 2D Speckle Tracking Echocardiography (2D-STE).

Results: Conventional 2D-Echocardiography clearly identified the most frequent morphological myocardial disorders AN-related. On the contrary, 2D-STE is useful in to identify some complications of LV motion before their appearance, as dilatative (or congestive) and stress(or Tako-Tsubo) cardiomyopathy.

Conclusions: 2D-Echocardiography is an useful ultrasonic technique to individualize the most frequent structural myocardial abnormalities consequent to severe AN. But, 2D-STE are able to precociously recognize abnormal motion of LV indicative of pre-clinical LV derangement, as dilatative or stress-cardiomyopathy.

Keywords: Anorexia Nervosa; Conventional Echocardiography; 2D Speckle Tracking Echocardiography

Introduction

Anorexia nervosa (AN) is an eating disorder induced by persistent energy intake restriction and disturbance in self perceived weight and shape and, in many individuals, distorted body-image [1]. The causes of AN individually change according to genetic predisposition and environmental, social and cultural factors. Frequently, AN is diagnosed in young female but, it can also happen in adolescents, both males and females [2]. It can be diagnosed according to DSM-5 following criteria in three main disturbed-types of eating [3,4]:

1. Restriction of energy intake relative to requirements leading to a significantly low body weight in the context of age, sex, developmental trajectory, and physical health.
2. Intense fear of gaining weight or becoming fat, even though underweight.
3. Disturbance in the way in which one’s body weight and shape on self-evaluation, or denial of the seriousness of the current body weight.

Two main subtypes of AN were more frequently recognized [5]:

1. Restricting subtype, characterized by severe restriction of foods. The restrictive behavior can be further worse by excessive physical activity.
2. Purging subtype, when to dietary restriction adds purging behavior or self inducing vomiting and/or the use of diuretics or enemas.
AN is associated with numerous medical complications [6,7], responsible for more than half of all deaths [8]. These can be divided in cardiovascular and extracardiovascular complications, according to their location (Table 1). Cardiovascular disorders include numerous changes contributing to elevated morbidity of these patients. In these are comprised some arrhythmogenic disturbances (rhythm and conduction abnormalities) and morphologic or structural myocardial changes. The most frequent cardiac disorders recorded in individuals are: bradycardia, hypotension, arrhythmias, repolarization disorders and sudden death often associated with prolongation of S-T interval. Their aetiology consist in overactive parasympathetic nervous system, electrolyte disturbances, dehydration, and other causes consequent to excessive caloric restriction, laxative and/or diuretic abuse or purging. But, AN can be also associated with some structural (or morphologic) myocardial changes, such as pericardial effusion, mitral valve prolapse and some cardiomyopathies [9-11]. The most frequent, structural cardiac complications only will be illustrated here.

<table>
<thead>
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<th>Main complications of Anorexia Nervosa</th>
<th>Cardiovascular</th>
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<td>Osteoporosis</td>
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<td>Constipation</td>
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*Table 1: The most frequent cardiovascular and extravascular disorders induced by AN.*

**Mitral valve prolapse**

Mitral valve prolapse (MVP) is often present in patients with AN and can involve either anterior and posterior mitral leaflet (Figure 1). Cheng and others explained that MVP results from excessive mitral valve tissue, due to the valvulo-ventricular disproportion with relative redundancy of mitral limbs or inadequate LV cavity [12,13]. Nevertheless, this would expected to reverse with weight restoration. This condition can also become with rhythm disturbances often reaching to sudden death, induced by Q-T dispersion [14].

*Figure 1: Apical four chambers approach. Redundancy of mitral leaflets and thinning of LV walls.*
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Pericardial effusion

It is present in many AN individuals, ranging from 20% to 70% [15,16]. The causes are numerous, among these are comprised: low body mass index, low T₃ and/or insulin like-growth factor-1 levels. It is well known that GH, FT3 and IGF-1 exert potent physiologic trophic effects on the myocardium. Several studies reported that transient hypothyroidism and the low T₃ syndrome are due to malnutrition, and these conditions can be corrected by restoring the body weight [17]. Malnutrition and longstanding hypovolemia represent other two potential causes of pericardial effusion (Figure 2) [18]. Pericardial effusion in AN can be a result of the inappropriately high protein supply and sodium repletion, with resulting expansion of the extracellular space. This myocardial complication can evolve in to pericardial tamponade requiring pericardiocentesis, or in complete resolution after weight restoration [19,20].

Cardiomyopathies

Cardiomyopathy, or literally sick syndrome, is another myocardial change frequently occurring in AN, that often lead to heart failure. 2D Echocardiography is a non-invasive method to see a reduction in the dimensions of the interventricular septum (IVS) and LV free wall (Figure 3). On the other hand, this reduction induce several histologic abnormalities responsible for impairments of cardiac muscle, such as vacuolization and fragmentation of myofibrils, replacement of fibrosis and loss muscle's fibers [21,22]. In the late phase of AN, heart failure is predominant, but its causes aren’t completely known. The main symptoms associated with heart failure are shortness of breath, fatigue, tachycardia and oedema. Probably, heart failure could be the result of very low phosphorus. Deficiencies in thiamine magnesium and selenium have also been reported. These nutritional deficiencies can be corrected by the restoration of body weight [23,24].
Some cases of Tako-Tsubo Cardiomyopathy (TTC), or stress-cardiomyopathy, were described among AN-related cardiomyopathies [25]. Although the coronaryography is the gold standard for right diagnosis of TTC, 2D-Echocardiography is an ideal, non-invasive tool for to visualize apical ballooning typical of TTC (Figure 4) [26,27]. Its pathophysiology isn’t completely well-known but, that is probably due to the catecholamines’ release during hyponutrition. Specifically, hypoglycaemia and oestrogen deficiency induced by AN favour the increased serum concentration of catecholamines [28]. The consequent changes of vasomotor reactivity may make these patients more vulnerable [28-30].

![Figure 4: Dilatation of LV apex (Tako-tsubo cardiomyopathy) recorded from left apical approach.](image)

But, here underlined the importance of 2D-Speckle Tracking Echocardiography (2D-STE) useful for characterization and quantification of myocardial deformation of myocardial walls during the cardiac cycle [31]. This advance in cardiac imaging, respect to those obtained with conventional 2D-Echocardiography, consents a more comprehensive assessment of myocardial performance. In particular, 2D-STE is able to early assess LV global and regional function, before of the appearance of overt symptoms, as pointed out by the following 2D-STE image (Figure 5), characterized by a poor coordination of regional strain curves and normal global LV function [32]. The finding obtained in a young patient with AN, is characterized by a poor coordination of regional strain curves, while the curve of global LV was normal. That is indicative of pre-clinical LV impairment, when LV global function is normal too.

![Figure 5: Longitudinal strain of LV-Poor regional coordination (strain curves stained), while LV global function appears still normal (white strain curve).](image)
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Conclusive Remarks

After suicide, cardiac complications are the most common cause of death in patients suffering of AN [33]. Fortunately, most of these are reversible with the body’s weight restoration. Among myocardial disorders, bradycardia, systemic hypotension, Q-T prolongation, electrolytes’ disturbances, arrhythmias are the most frequent causes of morbidity and mortality in anorexic patients. But, changes in LV mass and geometry, pericardial effusion, mitral valves redundancy, and cardiomyopathies, included Tako-tsubo cardiomyopathy, can be also frequently recognized. These disorders were usually seen by 2-D Echocardiography. But, recent ultrasonic techniques, such as 2D-STE can be useful to diagnose these abnormalities in the sub-clinical phase too, when structural changes aren’t still evident, allowing too early and easily treat.

Ethical Standards

Human and/or Animals Studies

This article does not contain any studies with human participants or animals.

Conflict of Interest

F.C. has no conflicts of interests.

Bibliography


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