The Obese Heart

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Introduction

Obesity has been described as a chronic metabolic disease, characterized by excessive adiposity.[1] Most discussion about the consequences and complications of obesity revolves around metabolic dysfunction, such as dysglycaemia, dyslipidaemia and hypertension. There is also increasing awareness about ectopic adipose tissue deposition and its deleterious effects.[2] Fatty liver, fatty pancreas and fatty kidneys are terms that are used frequently in clinical descriptions of the disease. In spite of the strong link between obesity and cardiac ill-health, the term 'obese heart' or 'fatty heart', however, has not found traction in medical literature. This may be due to the complexity of obesity's impact on the heart.

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Obesity And The Heart

Obesity is not just a disease in itself; it is a risk factor for various other diseases also. It is a part of the metabolic syndrome, which includes other cardiovascular risk factors as well. It may become, difficult, therefore, to differentiate obesity induced structural abnormalities and dysfunction from that caused by diabetes, hypertension or other associated illnesses.[3]

The heart is an important structure of the body, and is impacted by obesity as much as other organ systems. Advances in cardiac imaging have facilitated detection of subclinical abnormalities in obesity at early stages. This has highlighted the importance of obesity as an independent risk factor for atherosclerotic cardiovascular disease, heart failure, atrial fibrillation, and sudden cardiac death.[4]

In this review, we describe various clinical presentations of the obese heart, including cardiac adipose tissue deposition, obesity cardiomyopathy, electrophysiological abnormalities such as atrial fibrillation, and associated comorbidities. (Table)

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Atherosclerotic Cardiovascular Disease

Obesity accelerates atherosclerosis, by depositing cholesterol esters in vascular endothelium, through multiple mechanisms. Central obesity or visceral obesity, rather than subcutaneous obesity, is linked more closely to atherosclerosis. Persons with obesity have a higher risk of coronary artery disease. Half of this association may be explained by elevated blood pressure, cholesterol and glucose. The other half of the risk is directly due to obesity. While generalized obesity is obviously associated with adverse cardiovascular health, this is also true for persons with normal weight obesity (NWO). NWO is characterised by normal body mass index, but high body fat percentage, and is associated with as high risk of cardiovascular morbidity. The obese heart is also characterised by abnormal coronary microvasculature, and small vessel remodeling which in turn presents as endothelial dysfunction.[4,5]

Sodium Retention

Obesity leads directly to sodium retention. This occurs through multiple pathophysiological pathways, including activation of the sympathetic nervous system, renin-angiotensin aldosterone system, and mineralocorticoid receptors. It is associated with sodium sensitivity also. All these factors lead to volume and pressure overload.[6]

Obesity Cardiomyopathy

This overload leads to hypertrophy of the cardiac chambers. Left atrial, left ventricular and right ventricular enlargement can present in various ways. Both eccentric and concentric hypertrophy of the left ventricle can occur, with the former variant more common in women. This disease state is termed as obesity cardiomyopathy.[7] Obesity is a risk factor for hypertension and atherosclerotic cardiovascular disease (ASCVD). These, in turn, are risk factors for the development of heart failure with preserved ejection fraction (HFpEF) and heart failure with reduced ejection fraction (HFrEF). HFpEF, however, is a more commonly encountered obesity cardiomyopathy than HFrEF. Apart from obesity, impaired physical fitness is also a risk factor for heart failure. Paradoxically, persons with obesity have lower levels of brain natriuretic peptide (BNP) than their lean

Table: The Obese Heart.

ECTOPIC ADIPOSE TISSUE DEPOSITION
• Paracardial adipose tissue (PAT)
• Epicardial adipose tissue (EAT)
• Perivascular adipose tissue (PVAT)
MYOCARDIAL STRUCTURE/SHAPE/SIZE
• Obesity cardiomyopathy
• Left atrial enlargement
• Left ventricular hypertrophy
o Concentric
o Eccentric
• Right ventricular hypertrophy
PULMONARY BED
• Pulmonary hypertension
• Venous thrombo-embolism
AORTIC VALVE STENOSIS
ATRIAL FIBRILLATION
• Alterations in cardiac structure
• Physical impact of EAT
• Infiltration by EAT
• Proinflammatory cytokine release
• Proinflammatory macrophage differentiation

counterparts. The obesity paradox, i.e., the protective effect of obesity, is noted with HFrEF, HFpEF, and acute decompensated heart failure.

Paracardiac Obesity

An ectopic fat deposit is a lipid deposit that is found in organs apart from the adipose tissue. Pericardial adipose tissue (PAT) detected by CT scan is the total fat content within the pericardiac sac, below the superior extent of the left or right main coronary artery. Epicardial adipose tissue (EAT) is the name given to the visceral fat between the outer wall of the myocardium and the visceral layer of the pericardium. This originates from embryonic brown adipose tissue. Both PAT and EAT are metabolically and hormonally active fat deposits, which contribute to insulin resistance, cardiovascular risk, and poor cardiovascular outcomes. They are associated with comorbidities, steatohepatic disease, and obstructive sleep apnoea. The obese heart is characterized by excessive deposition of PAT and EAT.[4]

The Adipose Atria

Obesity is a risk factor for atrial fibrillation. Obesity is thought to account for 20% of all atrial fibrillation (AF) cases, and for 60% of the increased incidence in recent years. Each 5-unit increment in BMI is associated with a 29% increased risk of AF, a 10% rise in post-operative AF, and a 13% higher risk of post ablation AF. This arrhythmia may occur due to left atrial enlargement, mechanical pressure by epicardial fat, infiltration of fat, and interference with physiological electro-conducting tissues through mechanical factors, pro inflammatory macrophages, and proinflammatory cytokines.[4,6] We term this constellation of structural and functional alteration as 'the adipose atria.'

Aortic Sclerosis

Aortic sclerosis is a commonly encountered valvular condition, and it may lead to aortic stenosis. Aortic valve stenosis is the clinical manifestation of calcific aortic valve disease. Age, male sex, high blood pressure, elevated low-density lipoprotein (LDL) cholesterol and smoking are conventional risk factors for aortic valve stenosis New, large observational and genetic studies have now placed obesity as an important risk factor for aortic sclerosis as well.[8]

Pulmonary Vascular Disease

The pulmonary vasculature is also altered in obesity. Persons living with obesity are at a higher risk of both pulmonary hypertension and pulmonary embolism. They may need higher doses of anti-coagulants.[4]

Sudden Cardiac Death

Obesity is associated with sudden cardiac death (SCD). Each 5-unit increment in BMI leads to a 16% higher risk of SCD. Obesity is the most frequent nonischaemic cause of SCD, which may occur due to ventricular tachycardia/ ventricular fibrillation. The proarrhythmogenic effect of obesity is due to mechanical as well as functional mechanisms. Obesity also interferes with the efficacy of chest compression, airway maintenance, and defibrillation procedures.[4]

Implications For Diagnosis

Persons with obesity must be screened for heart disease. Specifically, persons living with obesity must be screened proactively for ASCVD, heart failure, and atrial fibrillation. Some diagnostic modalities, such as echocardiography, may not have the expected sensitivity in obese persons. This may limit their usage for screening and monitoring the obese heart.

Obesity may impact the accuracy of electrocardiogram (ECG) tracings by displacement of the heart (elevation of the diaphragm in supine positive), increasing the distance of the electrodes from the heart (due to fat), and increasing the cardiac workload. ST segment depression, and left ventricular hypertrophy (LVH) ECG criteria are commonly found in obesity.

Stress echocardiography is a useful diagnostic tool, and can be used, with contrast, in persons with obesity. Persons with severe obesity or large breast size offer poor

acoustic windows, and the operator-dependent nature of stress echocardiography may be a limitation. Transesophageal echocardiography is another option for imaging of the obese heart.

Treadmill test (TMT) performance is limited in obese persons, because of poor physical conditioning, pulmonary dysfunction, orthopaedic challenges, and left ventricular diastolic dysfunction. Persons living with obesity may terminate TMT because of fatigue, leg pain, or dyspnoea.

Stress cardiac magnetic resonance imaging (MRI) helps in assessing perfusion wall motion and ejection fraction. This is useful for persons with obesity, though individuals with very heavy body weight (~150kg) may not be able to fit on the MRI table. A similar challenge is faced with CT calcium scan and coronary angiography. Single photon emission CT (SPECT), using technetium sestamibi is a useful tool for persons living with obesity, if the BMI is ≤ 35 kg/m^2. Apart from this, attenuation artifacts, and technical limitations preclude accurate detection of triple vessel or left main artery disease. Position emission tomography (PET) offers faster, better-quality imaging, with less radiation exposure, irrespective of severity of obesity. This is the nuclear imaging technique of choice for the obese heart.[4]

Coronary angiography is a challenging procedure in persons with obesity. Radial access should be preferred to femoral approach. Intravascular imaging techniques, such as ultrasound may also be used in persons living with obesity.[4]

Implications For Treatment

Cardiovascular risk mitigation strategies must be put in place to optimize outcomes. Chief among these is weight reduction. The benefits of weight loss on cardiovascular health are well documented, and must be explained to all stakeholders. Weight optimization can be achieved through intensive behavioural therapy, non-pharmacological interventions, pharmacological therapy, as well as bariatric surgery, as required. Exercise has been shown to reduce PVAT, even in the absence of weight loss, with aerobic exercise having better results. Caloric restriction also reduces PAT and PVAT.[4]

Platelet reactivity is higher in persons with obesity. It has been suggested that ticagrelor or prasugrel is more effective than clopidogrel in obese persons. As per current guidelines, however, antiplatelet therapy should not be adjusted based on body weight.[4]

Cardio-safe and cardio-beneficial drugs, as well as therapies that are not associated with weight gain, must be used for persons living with obesity. Newer drugs such as semaglutide and tirzepatide have been shown to improve heart failure outcomes, and improve cardiovascular health.[9,10] Obesity is associated with higher mortality, but lesser bleeding rate, after percutaneous coronary intervention (PCI) and coronary artery bypass graft (CABG). Higher anticoagulant dose is required in persons with obesity. The risk of contrast-induced nephropathy, dialysis requirement, and operative complication is higher in persons with obesity.

Obesity Paradox

The obese heart may be the subject of the obesity paradox, which posits that obesity, as measured by BMI, may not accurately predict outcome in persons with cardiovascular disease. This may be explained by differential deposition of adipose tissue, and by physical fitness levels.[11] The obesity paradox, i.e., lesser cardiovascular events and death, is evident in persons with class 1 or 2 obesity, with respect to heart failure, and also after PCI and CABG.[4]

Summary

The obese heart is a distinct anatomical entity, with pericardiac, myocardial and coronary alterations. It is also a dysfunctional entity in terms of electric conduction. The impact of obese heart on morbidity and mortality is significant. Hence, adequate attention should be paid to weight management, to prevent and manage cardiac disease, in persons living with overweight or obesity.

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