Canadian Journal of Cardiology 31 (2015) 184–194

Review

# Obesity and Coronary Artery Disease: Evaluation and Treatment

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## ABSTRACT

**With the increasing prevalence of obesity, clinicians are now facing a growing population of patients with specific features of clinical presentation, diagnostic challenges, and interventional, medical, and surgical management. After briefly discussing the effect of obesity on atherosclerotic burden in this review, we will focus on strategies clinicians might use to ensure better outcomes when performing revascularization in obese and severely obese patients. These patients tend to present comorbidities at a younger age, and their anthropometric features might limit the use of traditional cardiovascular risk stratification approaches for ischemic disease. Alternative techniques have emerged, especially in nuclear medicine. Positron emission tomography-computed tomography might be the diagnostic imaging technique of choice. When revascularization is considered, features associated with obesity must be considered to guide therapeutic strategies. In percutaneous coronary intervention, a radial approach should be favoured, and adequate antiplatelet**

## RÉSUMÉ

**Avec l'augmentation de la prévalence de l'obésité, les cliniciens font face à une population croissante de patients présentant des caractéristiques spécifiques en termes de présentation clinique, de défis diagnostiques et thérapeutiques, en ce qui a trait à la prise en charge médicale et aux techniques de revascularisation. Après avoir brièvement discuté des répercussions de l'obésité sur l'athérosclérose, cet article mettra l'accent sur les stratégies que peuvent utiliser les cliniciens pour l'obtention de résultats optimaux concernant les questions de revascularisation chez les patients obèses et sévèrement obèses. Ces patients ont tendance à présenter des comorbidités à un plus jeune âge, et leurs caractéristiques anthropométriques peuvent limiter l'utilisation des approches de la stratification traditionnelle à la recherche d'ischémie myocardique. Des techniques alternatives ont vu le jour en particulier en médecine nucléaire. La tomographie par émission de positron (TEP rubidium) peut s'avérer la technique d'imagerie diagnostique de choix. Une fois**

In this review, we focus on strategies clinicians might use to ensure better outcomes when performing revascularization in obese and severely obese patients.

## Epidemiology

The most commonly used anthropometric tool to classify obesity is body mass index (BMI), the ratio of total body weight in kilograms divided by the height in meters squared ($kg/m^2$). The different classes of obesity are described in Table 1. Obesity is an independent risk factor for cardiovascular (CV) disease (CVD).[1,2] It also increases the incidence of traditional CV risk factors like hypertension, dyslipidemia, and diabetes mellitus, leading to a greater incidence of ischemic stroke and coronary heart disease.[1,3,4] Numerous studies have demonstrated that obesity is associated with angina, myocardial infarction (MI), heart failure, and sudden cardiac death.[5-7] The increased incidence of CV events in obese patients is related to endothelial dysfunction and subclinical inflammation, in addition to worse CVD risk factors.[8] Obesity is also associated with increased mortality.[9] Three large cohort studies concluded that obesity needs to be present for at least 20 years to become an independent risk factor for clinically significant coronary artery disease.[7,10,11] A recent meta-analysis demonstrated that overall, obesity is associated with increased all-cause mortality rates, with an odds ratio (OR) of 1.18; whereas significantly increased mortality was observed for classes 2 and 3 (OR of 1.29), but not for class 1

Received for publication December 4, 2014. Accepted December 10, 2014.

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See page 190 for disclosure information.

http://dx.doi.org/10.1016/j.cjca.2014.12.008

**therapy with new and more potent agents should be initiated. Weight-based anticoagulation should be contemplated if needed, with the use of drug-eluting stents. An "off-pump" approach for coronary artery bypass grafting might be preferable to the use of cardiopulmonary bypass. For patients who undergo bilateral internal thoracic artery grafting, harvesting using skeletonization might prevent deep sternal wound infections. In contrast to percutaneous coronary intervention, lower surgical bleeding has been observed when lean body mass is used for perioperative heparin dose determination.**

**la revascularisation considérée, les caractéristiques associées à l'obésité doivent moduler les stratégies thérapeutiques. Lors d'une intervention coronarienne percutanée (ICP), une approche radiale doit être favorisée et les nouveaux agents antiplaquettaires devraient être privilégiés. Lors d'une ICP, une anticoagulation titrée à partir du poids total du patient de concert avec l'utilisation des endoprothèses médicamenteuses est conseillée. Au sujet de la revascularisation chirurgicale, une approche de type « coeur battant » pour la revascularisation par pontage coronarien peut conférer des avantages supplémentaires par rapport à l'utilisation de la circulation extracorporelle. Pour les patients où le chirurgien utilise les deux artères mammaires internes, le prélèvement de l'artère par squelettisation a montré des avantages intéressants pour prévenir les infections de plaie sternale profonde. Un risque de saignement chirurgical plus faible a été observé quand la masse maigre du patient est utilise pour la détermination des doses périopératoires d'héparine.**

(OR of 0.95).[12] Obesity assessed according to BMI alone presents some limitations,[13] and other adiposity indices might provide a better CV risk assessment. In the INTERHEART study, waist-to-hip ratio (WHR) was the strongest predictor of MI, with waist circumference (WC) and waist-to-height ratio being stronger markers than BMI alone.[14] Consequently, fat distribution might be very important in evaluating patient risks. In the **Tra**ndolapril **C**ardiac **E**valuation (TRACE) registry, increased mortality was observed among patients with previous CVD who presented with abdominal obesity.[15] This relationship remained strong after the exclusion of diabetes and hypertension, underlining the importance of abdominal obesity as an independent factor. Excess abdominal visceral adipose tissue, regardless of BMI, has been associated with diabetogenic and atherogenic abnormalities like insulin resistance, increased triglycerides, and apolipoprotein B levels, low high-density lipoprotein cholesterol and increased small dense low-density lipoprotein and high-density lipoprotein particles.[16,17] In contrast, low levels of visceral adipose tissue are associated with a better metabolic risk profile.[18]

## Obstructive Coronary Artery Disease and Obesity

The **Pa**thobiological **D**eterminants of **A**therosclerosis in **Y**outh (PDAY) study, based on postmortem examination of arteries from young individuals who died from accidental injuries, homicides, or suicides, was landmark in understanding the relationship between atherosclerosis and obesity.[19] This study documented that obesity in adolescents and young adults accelerates the progression of atherosclerosis decades before the appearance of clinical manifestations, and that high BMI correlates with more complex lesions (more fatty streaks, raised lesions, and high-grade American Heart Association pathological criteria for complex lesions). Greater panniculus thickness was associated with more complex lesions in patients with a BMI $\geq$ 30 regardless of age.[19] These data support the importance of regional fat distribution as a modulator in CVD development. These findings were corroborated by the **F**ire Fighter **a**nd **T**heir **E**ndothelium (FATE) study, in which various anthropometric indices of obesity and subclinical atherosclerosis using carotid intimal-medial thickness were evaluated.[20] WHR was the strongest adiposity-related index associated with atherosclerotic burden. The Dallas Heart study[21] demonstrated that the WHR was the only anthropometric index of obesity associated with the prevalence of coronary artery calcium in multivariate analysis, with an OR of 1.91. Thus, obese patients, especially with abdominal fat, show earlier and more complex atherosclerotic burden with a higher related CV mortality than normal-weight patients.

## Evaluation of Cardiac Function and Structure in the Obese Patient

### Electrocardiogram

The electrocardiogram (ECG) is modified by structural changes related to obesity. The heart is displaced by diaphragmatic elevation in the prone position. Increased circulating blood volume leads to increased stoke volume, which increases cardiac output and results in left chamber hypertrophy.[22] Subcutaneous and epicardial fat influences ECG because of the increased distance between the heart and the electrodes.[1] These ECG findings are well defined in the landmark study in 1029 obese patients (Table 2), and high

**Table 1.** ECG findings in obesity

| |
|---|
| ↑ HR (↑10% weight → ↑ 0.76 bpm) |
| Repolarization abnormalities (11%) |
| ST abnormalities (10.6%) |
| T-wave abnormalities (11.7%) |
| ↑ PR interval (↑10% weight → ↑ 0.5 ms) |
| Axis deviation (↑10% weight → ↑ 1.8° toward the left) |
| ↑ QRS duration |
| ↑ QTc interval |

bpm, beats per minute; ECG, electrocardiogram; HR, heart rate.

**Table 2.** Classification of obesity according to BMI

| | |
|---|---|
| Underweight | BMI < 18.5 |
| Normal or acceptable weight | BMI 18.5-24.9 |
| Overweight | BMI 25-29.9 |
| Obese | BMI $\geq$ 30 |
| Grade 1 | BMI 30-34.9 |
| Grade 2 | BMI 35.0-39.9 |
| Grade 3 | BMI $\geq$ 40 (severe, extreme, or morbid obesity) |

BMI, body mass index (calculated as weight [kg]/height [$m^2$]).