Clinical Research

Young Women With Abdominal Obesity Have Subclinical Myocardial Dysfunction

Bianca L. Share, BSc(Hon),[a] André La Gerche, MBBS, PhD,[a,b]
Geraldine A. Naughton, PhD,[a,c] Philippe Obert, PhD,[a,d] and Justin G. Kemp, PhD[a]

[a] School of Exercise Science, Australian Catholic University, Melbourne, Australia
[b] Cardiac Investigation Unit, St Vincent's Hospital, Melbourne, Australia
[c] Murdoch Childrens Research Institute, Royal Childrens Hospital, Melbourne, Australia
[d] LAPEC, EA4278, Avignon University, Avignon, France

ABSTRACT

Background: Abdominal obesity is an independent risk factor for cardiovascular disease. The effect of abdominal obesity on myocardial function in young obese women remains unknown. Therefore, we aimed to investigate cardiac morphology and function, myocardial deformation, and mechanical indices, in young women with and without abdominal obesity.

Methods: Cross-sectional analyses of 39 women with abdominal obesity (waist circumference $\geq$ 80 cm) and 33 nonobese control subjects (waist circumference < 80 cm) aged 18-30 years underwent conventional echocardiographic measures of cardiac morphology and function together with tissue Doppler, and 2-dimensional speckle tracking measures of myocardial deformation and mechanics. Cardiometabolic risk factors including anthropometric, hypertension, biochemistry, and fitness were also assessed.

Results: Standard echocardiography results for cardiac morphology and function were similar between groups, with the exception of larger left atrial dimensions in women with abdominal obesity ($P \leq 0.05$).

RÉSUMÉ

Introduction : L'obésité abdominale est un facteur de risque indépendant de la maladie cardiovasculaire. Nous ignorons les conséquences de l'obésité abdominale sur la fonction du myocarde chez les jeunes femmes obèses. Par conséquent, notre but était d'examiner la morphologie et la fonction cardiaque, la déformation du myocarde et les indices mécaniques chez les jeunes femmes souffrant ou non d'obésité abdominale.

Méthodes : Les analyses transversales de 39 femmes souffrant d'obésité abdominale (tour de taille $\geq$ 80 cm) et 33 sujets témoins non obèses (tour de taille < 80 cm) qui étaient âgées de 18 à 30 ans ont subi des mesures échocardiographiques traditionnelles de la morphologie et de la fonction cardiaque par Doppler tissulaire et des mesures par échocardiographie bidimensionnelle *Speckle Tracking* (suivi de pixel) de la déformation et de la mécanique du cœur. Les facteurs de risque cardiométabolique, y compris l'anthropométrie, l'hypertension, la biochimie et la condition physique ont également été évalués.

Obesity is an established independent risk factor for cardiovascular disease (CVD), with prevalence reaching epidemic proportions.[1] In countries such as Australia, the prevalence of obesity in young women appears to be increasing at an exponential rate.[2] Increased waist circumference (WC) is a reliable anthropometric index of abdominal obesity[3] that allows early identification of CVD risk.[4] However, the cardiac consequences of risk factors are poorly understood in young women; a population emerging as highly vulnerable to cardiometabolic disorders.

Young women specifically continue to be underrepresented in cardiac research,[5] perhaps because of the misperception that

women are 'protected' against CVD via the role of estrogen in premenopausal women.[6] Additionally, enrollment of women in clinical and epidemiological research remains relatively low in studies of populations with chronic disease.[7]

Obesity can unfavourably alter left ventricular (LV) morphology and function with greater LV hypertrophy and cardiac remodelling observed in adolescent,[8] middle-aged women,[9] and older female populations.[10] Early detection of myocardial abnormalities in obese individuals might represent a critical and cost-effective strategy to attenuate the time-related consequences of CVD.[10] Despite this, the understanding of the effects of obesity on CVD risk in women is largely limited to middle-aged and older individuals with scarce attention to young obese women.[11-13] Therefore, it remains unclear whether obesity in young women is associated with cardiac dysfunction. As such, identification of subclinical disease such as myocardial dysfunction in young women with obesity would highlight a group in which targeted interventions might have the greatest effect.

Compared with control subjects, women with abdominal obesity also demonstrated reduced systolic and diastolic mitral annular plane velocities, increased left atrial pressure surrogates (E/diastolic mitral annular plane velocity), and prolonged timing measures of diastolic function including isovolumic relaxation time and transmitral deceleration time ($P \leq 0.05$). In addition, longitudinal strain and diastolic strain rate were reduced in women with abdominal obesity ($P \leq 0.05$) but circumferential deformation and myocardial mechanics (twist indices and rotation) were preserved. Markers of abdominal obesity retained an independent direct correlation with parameters of cardiac dysfunction, explaining 12%-39% of the overall variability.

Conclusions: A young, otherwise healthy group of women with abdominal obesity displayed subclinical cardiac dysfunction indicated using selected tissue Doppler imaging and speckle tracking echocardiography measures.

Résultats : Les résultats de l'échocardiographie standard de la morphologie et de la fonction cardiaque étaient similaires entre les groupes, à l'exception des dimensions plus grandes de l'oreillette gauche chez les femmes souffrant d'obésité abdominale ($P \leq 0,05$). Comparativement aux sujets témoins, les femmes souffrant d'obésité abdominale démontraient également une réduction des vitesses systoliques et diastoliques du plan de l'anneau mitral, une augmentation des substituts de la pression auriculaire gauche (E/vitesse diastolique du plan de l'anneau mitral) et des mesures prolongées de la durée de la fonction diastolique, y compris le temps de relaxation isovolumique et du temps de décélération du flux transmitral ($P \leq 0,05$). De plus, la déformation longitudinale et le taux de déformation diastolique étaient réduits chez les femmes souffrant d'obésité abdominale ($P \leq 0,05$), mais la déformation circonférentielle et la mécanique du myocarde (indices de torsion et rotation) étaient préservées. Les marqueurs de l'obésité abdominale conservaient une corrélation directe indépendante avec les paramètres de la dysfonction cardiaque, ce qui explique 12 % à 39 % de la variabilité globale.

Conclusions : Un groupe de femmes jeunes, mais en santé, souffrant d'obésité abdominale montraient une dysfonction sous-clinique cardiaque selon les mesures de l'imagerie Doppler tissulaire et de l'échocardiographie *Speckle Tracking* (suivi de pixel).

Subclinical cardiac dysfunction can be detected using noninvasive conventional and tissue Doppler imaging (TDI) echocardiography.[14] However, speckle tracking echocardiography (STE), a deformation imaging technique, was developed to address potential limitations in the sensitivity of existing measures for detecting subtle myocardial dysfunction.[15,16]

The aim of this study was to investigate cardiac morphology and function, myocardial deformation, and mechanical indices, in a cross-sectional profile of young women with and without abdominal obesity using traditional and advanced techniques of echocardiography.

Methods

Participants

Ninety-three university-enrolled participants responded to recruitment advertisements that specifically sought Caucasian women aged 18-30 years. Participants were free of hypertension, diabetes, smoking, endocrine disorders, had not undergone bariatric surgery, and were not pregnant or breastfeeding. Eleven women did not meet the inclusion criteria and 10 eligible participants did not complete testing. Therefore, 72 women completed testing between August 2010 and February 2012. Participants were divided into 2 groups: (1) 39 women with abdominal obesity defined by a WC $\geq$ 80 cm; and (2) 33 women without abdominal obesity (WC < 80 cm). Five women in the abdominal obesity group were previously pregnant to full-term ($\geq$ 1.5 years ago). Participants arrived at the laboratory after a 12-hour fast and were requested to refrain from strenuous physical activity in the 24 hours before testing.

The study was approved by the Australian Catholic University Human Research Ethics Committee (V2009-91), and participants provided written informed consent.

Cardiometabolic risk factors

A range of clinical characteristics were assessed to profile the population including anthropometric, blood pressure, blood biochemistry, and fitness variables (see the *Cardiometabolic Risk Factors* section of the Supplementary Material).

Echocardiography examination

Participants underwent a standard 2-dimensional transthoracic echocardiography examination for the assessment of global and regional ventricular function in accordance with the American Society of Echocardiography.[17] Image acquisition was performed by the same experienced operator using commercially available ultrasound equipment (Vivid *i*, GE Healthcare, Horten, Norway) with a 3.5 MHz phased-array transducer. Participants were examined in the left lateral decubitus position in a dark room and connected to a 3-lead electrocardiogram. A minimum frame rate of 70 Hz was used during acquisition of greyscale cine loops. Digital data were stored for subsequent off-line analyses with specific software (EchoPAC v108, GE Medical Systems, Horton, Norway) by an observer blinded to group assignment. All reported measurements were averaged from 3 consecutive cardiac cycles (see the *Echocardiography Examination* section of the Supplementary Material).

Statistics

Data were analyzed using IBM SPSS Statistics, Version 20 for Windows (Chicago, IL). Log transformation was used when qualitative variables were not normally distributed.[18] Group comparisons were performed using independent *t* tests. Hedge *g* was used to calculate magnitudes of differences ($\geq$ 0.2, small; $\geq$ 0.5, medium; and $\geq$ 0.8, large).[19] A power analysis determined the power achieved for effect size on variables that were statistically significant. Multiple linear regression analysis based on a stepwise algorithm was used to