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Investigating the Relationship in Visceral Fat and Calcium Scoring from Post-Mortem CT Scans

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Abstract

This study sought to investigate for an association between visceral adipose fat and coronary artery calcium score (CACS) in post-mortem individuals, with a focus where the primary cause of death was secondary to heart related conditions. Numerous studies have established a relationship between visceral fat with cardiovascular disease (CVD) with CACS having shown a relationship with vessel plaque burden, thus providing an indication of the severity of coronary atherosclerosis.

163 deceased patients underwent post mortem computerised tomography (CT) scanning in the setting of sudden death. Causes of death were categorised into coronary heart disease (CHD), ischaemic heart disease (IHD), or non-cardiac related causes. CACS was numerically classified as mild (0-10), moderate (10-100), moderate-severe (100-400), or at least 1 probable stenosis (>400). Though post-mortem CACS may be a useful assessment tool to assist in predicting the likely cause of death the measure used isn't representative of visceral fat when compared to CACS.

Keywords

Calcium score, Computerised Tomography (CT) scan, Coronary Heart Disease, Ischaemic Heart Disease, Visceral fat.

INTRODUCTION

Obesity is well recognised as a risk factor for CHD [1] with increased mortality being established in individuals over 50 years across ethnic groups and both genders with an increased body mass index (BMI) [2]. Visceral obesity appears to be strongly associated with an increased risk of cardiovascular related concerns [3] with pro-inflammatory cytokine levels increasing [4] and insulin sensitivity decreasing [5]. Estimation of the visceral adiposity with waist circumference is used as a CVD risk factor. Waist circumference, which is utilised as part of the diagnostic criteria for metabolic syndrome, may reflect the effects of visceral accumulation on cardiac events and mortality better than BMI [6] [7]. Increased visceral tissue measured by CT has been found to be an independent predictor for the severity of CHD and CACS among older age groups [8] [9]. The visceral adiposity index (VAI) has been developed to identify visceral adiposity dysfunction and acts as an indicator of visceral fat dysfunction, with several studies showing a correlation of VAI with cardiometabolic risk [10]. Coronary plaque calcification has been correlated with plaque burden; with CT providing quantitative data on the extent to coronary calcification [11]. CACS is a surrogate marker of atherosclerosis and a predictor of cardiac events [12]; with a predictive value of 0 indicating a low rate of cardiovascular event [13].

Few studies have investigated the relationship between visceral fat and calcium scoring in relation to cardiovascular risk. The aim of this study is to evaluate this association in post-mortem individuals.

METHODS

This multi-centre cross-sectional study included 163 deceased patients between 28-102 years of age (average 72.9 years) from the North-West England, all underwent a full body post-mortem multi-slice CT. There was a focus on the cause of death being reported to be secondary to heart related conditions such as IHD and CHD. CACS was calculated for the left coronary (LCA), left anterior descending (LAD), left circumflex (LCX), and right coronary arteries (RCA) in all cases.

The patients' medical history, demographics, and CACS were obtained from their post-mortem CT report. This included information such as age, gender, past medical history, and recreational drug history. CAC was measured at the level of the coronary vessels (this was reported by a radiology consultant), whilst visceral tissue was measured from the anterior boarder of the lumbar vertebral body to the subcutaneous tissue at the level of the umbilicus.

RESULTS

A total of 163 deceased patients with a mean age of 72.9 years, range 28-102 years, were included in this study. 67.5% (110/163) of those included in this study were men and 30.7% (50/163) were women; 82.5% (135) of deceased patients were aged 60 years or over. Information on gender and age was not available for 3 of the patients, and the cause of death for 1 patient was suspected to be secondary to a cardiac cause but was not yet established by the conclusion of this study. Causes of death were subdivided into IHD, CHD, and non-cardiac related deaths. CACS were subdivided into 4

categories based off severity as illustrated in table 1.

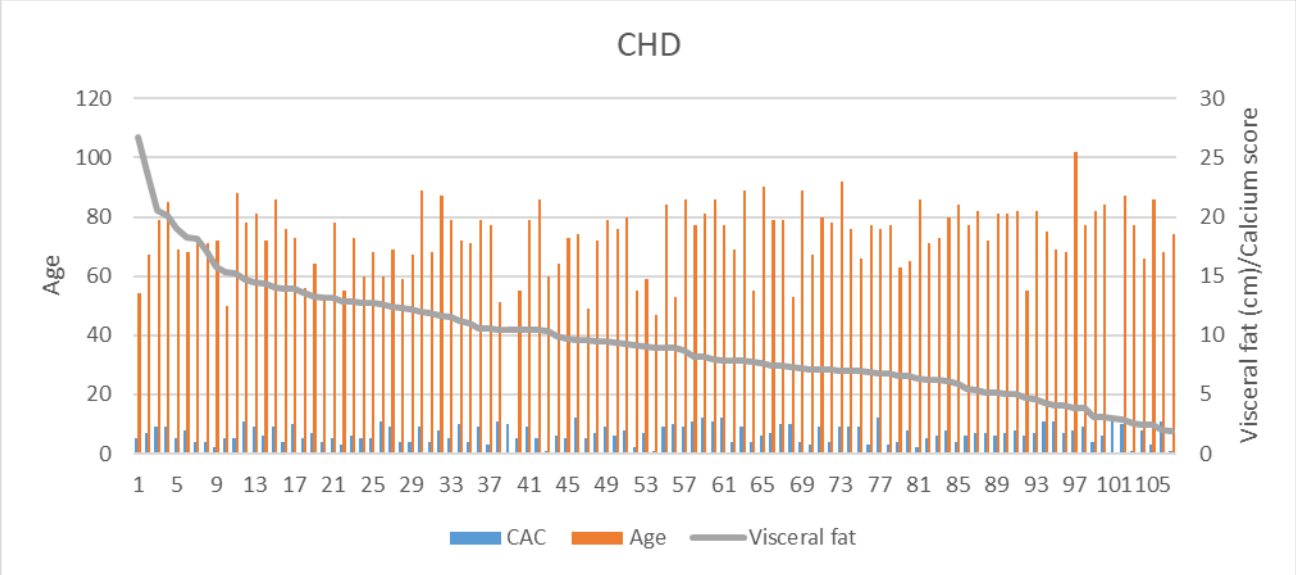
Table 1. Shows the categorising and scoring of the reported calcium score for each vessel.

Reported calcium score	Category	Score
0-10	Mild	0
10-100	Moderate	1
100-400	Moderate-Severe	2
>400	At least 1 probable stenosis	3

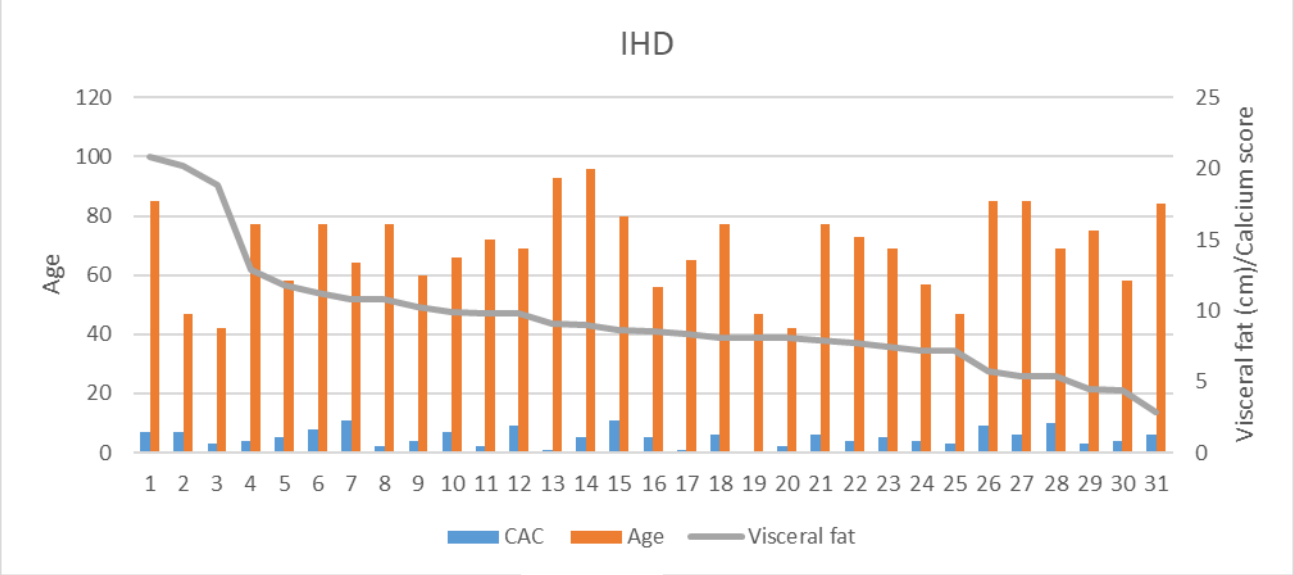
The reported calcium scores for each of the assessed vessels were scored (as per table 1) and the sum for all 4 vessels were then generated. Once a total score was generated a comparison of the visceral adipose length was put in ascending order and a comparison made to investigate whether higher visceral fat was correlated to the overall calcium score. Graphs 1-3 chart the age, visceral fat, and CACS for each individual assessed as part of this study.

The most common cause of death was from CHD; 108 (66.3%) patients passed away from CHD, 31 (19%) patients from IHD, and 23 (14.1%) patients from non-cardiac causes. For CHD the adipose fat (mean +/- standard deviation) was 9.5 +/- 4.7 cm, with the overall CACS being 6.8 +/- 2.9. For IHD adipose fat was 9.37 +/- 4.2 cm, with CACS being 5.2 +/- 2.9. Lastly, non-cardiac causes being 7.7+/-2.6 cm for adipose fat, and CACS being 6.3 +/- 3.3. For the non-cardiac cause pneumonia was the most common cause of death with asphyxiation being the second most common cause.

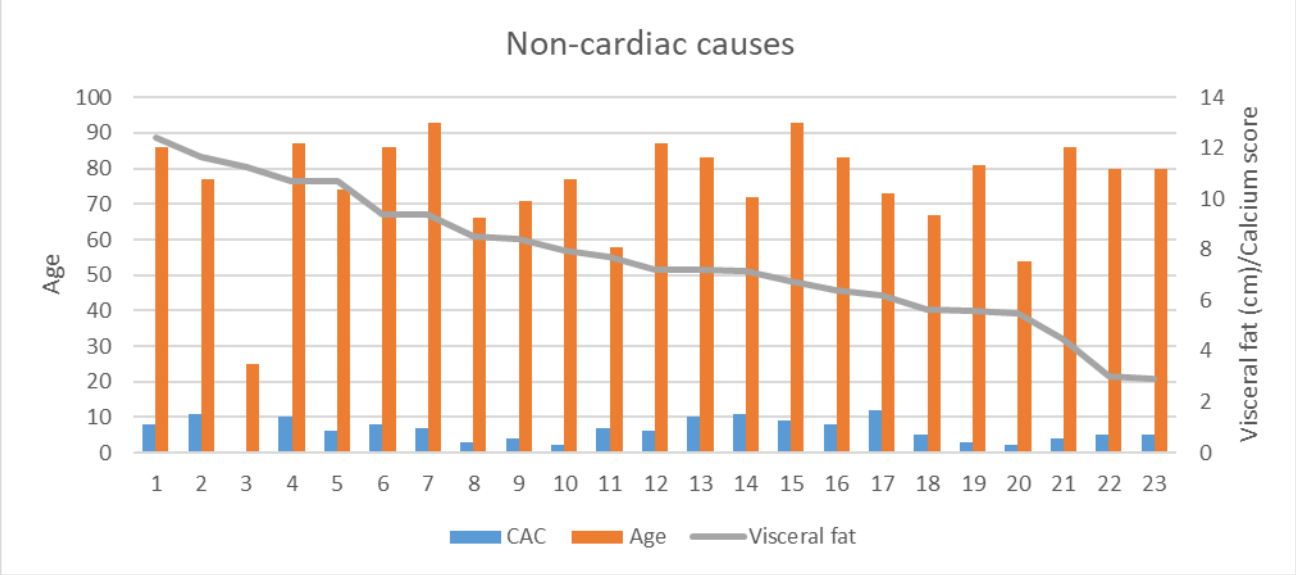
Overall in this model we did not find a conclusive association between the overall CAC of all the 4 cardiac vessels assessed to be correlated to visceral adipose fat length nor age. Where the cause of death was from CHD or IHD the overall CAC was higher among the LAD and lowest in the LCA.



Graph 1



Graph 2



Graph 3

Graph 1-3: illustrating visceral fat and calcium score with age of each cause of death among participants used in this study (CAC; Coronary calcium score). The x-axis represented each patient within the category.

DISCUSSION

Obesity is an established risk factor for CVD [14] with obese men being at higher risk of CHD than women [15]**.** Compared to subcutaneous fat, visceral fat accumulation is more pathogenic as it is considered to be more metabolically active and contributes to increased adipocyte dysfunction [16] that results in increased release of adipocytokines such as tumour-necrosis factor and interleukins (IL) such as IL-6 in addition to reduced secretion of adiponectin [17] [18] [19] [20]. Overall, this results in metabolic changes that contribute to insulin resistance, metabolic syndrome, and adiposity [21].

CT scanning helps with quantifying abdominal fat distribution in addition to helping distinguish between visceral and subcutaneous fat. In detecting calcium within the coronary arteries this places the coronary arteries into the definition of advanced atherosclerotic lesions. Therefore CACS can assist in providing an estimate of total coronary atheroma including non-calcified plaque burden [22]. Therefore, the extent of calcifications provides a prognostic value that is independent in long term follow up in assisting the prediction of cardiovascular related deaths; in addition to providing more accurate predictions of mortality than just utilising CVD related risk factors [23] [24] [25] [26]. *Bagyura, et al.* was able to suggest an association between VAI and CACS having significant implications in identifying patients at risk of atherosclerotic coronary artery disease [27].

CONCLUSION

This study has shown that the method utilised in investigating for any direct correlation between visceral fat and total CACS between the four coronary vessels evaluated was unsuccessful and therefore other methods would need to be sought in investigating visceral fat and whether there is a correlation with CACS.

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