The relationship between diabetes and abdominal fat distribution, as measured by CT scanning

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Abstract Background: Diabetes is rapidly becoming Australia’s fastest growing disease. Efforts to prevent or detect this disease earlier have led to research into risk factors which may be relevant. The objective of this project was to examine the relationship between diabetes and abdominal fat distribution as measured by computed tomography (CT) scanning.

Methods: A consecutive series of patients undergoing abdominal CT scanning, including 10 patients with type 2 diabetes and 32 patients without diabetes, who presented for CT scanning, were included in the study. Total abdominal and intra-abdominal fat (within the peritoneum) were measured from the CT images. Results: There was no significant difference between the mean age, weight and total abdominal fat of diabetics and non-diabetics. The diabetics had a greater amount of intra-abdominal fat (mean: 41.3 cm²) compared to the non-diabetic group (27.2 cm²); mean difference 14.1 cm², 95% CI: 1.4 cm²–26.8 cm², P = 0.028. The percentage of total abdominal fat that was intra-abdominal was also greater among diabetic patients; diabetic 35.3%, non-diabetic 27.6%; mean difference: 7.6%, 95% CI: 1.1%–14.2%, P = 0.02.

Conclusions: The results support the debate that location of abdominal fat within the peritoneum is more prevalent with diabetic subjects. Radiologists should consider this when reporting abdominal CT.

Keywords: Diabetes, CT scanning, intra-abdominal fat, total abdominal fat.

Introduction

Diabetes is Australia’s fastest growing chronic disease with one in four adults either diabetic or pre-diabetic.1 Diabetes is the seventh most frequent cause of death in Australia and is associated with a wide range of micro-vascular and macro-vascular complications.2

Previous studies have attempted to address the link between obesity and diabetes. Accumulation of abdominal fat, especially in the visceral space, has been claimed to have a causative role because of the secretion of adipocytokines from the fat tissue in this location.3 Researchers have previously indentified this fact and various attempts have been made to associate fat distribution with risk of development of diabetes.4 More recently, computed tomography (CT) has been employed by other authors for this purpose,5,6 although this is the first case-series study of a Caucasian population to be performed.

This study aims to further examine the link between fat distribution and type 2 diabetes. It utilises CT imaging which is a validated, accurate and definitive method of performing abdominal fat measurement, with the unique ability to precisely document its location.7,8

Materials and methods

The study population comprised a consecutive series of 42 patients, presenting to a CT department at Ipswich, Queensland, Australia between 8th August and 22nd August, 2005 for abdominal CT scanning. The study sample comprised 10 patients with type 2 diabetes and 32 patients without a history of diabetes or raised blood glucose. The reasons for undertaking the CT studies were unrelated to this study and included abdominal pain, investigation of visceral organ disease, assessment of altered pathology tests, and investigation of bowel disorders.

The study was approved by the Griffith University Human Research Ethics Committee. All participants gave informed consent on the procedure. No additional ionising radiation was required to complete the study.

Imaging was performed on a Philips IDT-10 10 slice CT scanner (Haifa, Israel). Overlapping 2 mm slices from diaphragm to symphysis pubis were obtained as part of the medical imaging required in accordance with department protocols. Imaging and calculations were performed by an accredited CT specialist radiographer with 20 years experience (GH). At the L4-5 disc level, two contiguous slices were loaded into the Philips 3-D package. Threshold was enacted to demonstrate the fat window optimally. Total fat was measured from the automated CT software. Intra-abdominal fat was measured via tracing and volume calculated from the CT software. Percentage of intra-abdominal to total abdominal fat was calculated. Other data collected included diabetes type, medication type, previous blood glucose assay, gender, age and weight.

Statistical analysis was performed with Stata (College Station, TX, USA). Results for each group were expressed as means and 95% confidence intervals (95% CI). Because the distributions for age, weight, total abdominal fat, intra-abdominal fat and percentage of intra-abdominal fat were all symmetrical, two-tailed t-tests were performed to assess differences between the two groups with regards to fat distribution, weight and age.

Results

Of the 42 patients in the study population, 10 had type II diabetes (six male, four female) and 32 did not have diabetes (15 male, 17 female). There were two exclusions from the study, due to malignancy. The final study population was 40, with 10 in the
Table 1: Comparison of mean (95% CI) values of age, weight and abdominal fat characteristics for non-diabetic and diabetic patients.

<table>
<thead>
<tr>
<th></th>
<th>Non diabetic (n = 30)</th>
<th>Diabetic (n =10)</th>
<th>Difference (Mean)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>Mean (95% CI)</td>
<td>Mean (95% CI)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>58.1 (51.2–65.0)</td>
<td>59.6 (53.1–66.1)</td>
<td>1.5 (10.4–13.5)</td>
<td>0.79</td>
</tr>
<tr>
<td><strong>Weight (kg)</strong></td>
<td>80.5 (71.1–89.9)</td>
<td>85.4 (74.4–96.4)</td>
<td>4.9 (-11.9–21.7)</td>
<td>0.56</td>
</tr>
<tr>
<td><strong>Total abdominal fat (cm²)</strong></td>
<td>100.4 (76.9–123.9)</td>
<td>114.4 (95.3–133.5)</td>
<td>14.0 (-26.4–54.4)</td>
<td>0.49</td>
</tr>
<tr>
<td><strong>Intra-abdominal Fat (cm²)</strong></td>
<td>27.2 (20.9–33.5)</td>
<td>41.3 (27.7–55.0)</td>
<td>14.1 (1.4–26.8)</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Percentage of intra-abdominal fat</strong></td>
<td>27.6 (24.4–30.9)</td>
<td>35.3 (28.1–42.4)</td>
<td>7.6 (1.1–14.2)</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Discussion

This study finds that the distribution of abdominal fat may be more important than the total abdominal fat in predicting the presence of diabetes. Despite the lack of difference between diabetics and non-diabetics with regards to total abdominal fat, the diabetic group had a greater amount of intra-abdominal fat and higher intra-abdominal to total abdominal ratio. A similar strong association has previously been noted between intra-abdominal fat and metabolic syndrome.

Several studies exploring the relationship between central obesity and diabetes risk via anthropometrical measurements have shown inconsistent results. This may be explained by the findings of this study. If the waist measurement was most predictive of diabetic status, then it would be expected that the CT total abdominal measurement of fat would have been different between the two groups; a finding not supported by these results.

Studies using CT to assess abdominal fat distribution with respect to diabetes have shown inconsistent results. Although none of these studies have been performed in a case-control manner, such as the present study, there has been no definitive answer as to whether abdominal fat location is clinically important with regards to diabetic status. The strongest evidence to date comes from a large prospective observational study of a Japanese population, and is consistent with these findings. This study observed Japanese participants over a period of 11 years and found that increased intra-abdominal fat area to be a significant and independent predictor of increased insulin resistance in those with preferential intra-abdominal fat location.

The main shortcomings of this study are its small size and the lack of information about possible confounders of the results. The absence of diabetes was not confirmed by definitive testing in the non-diabetic group. It points to the need for a case-control study comparing type 2 diabetics with age and weight-matched controls. Incorporation of a second case group with impaired glucose tolerance would show if there is an intermediate level of preferential storage of fat intra-abdominally in the pre-diabetic state.

Conclusion

These results have produced further evidence that definitive assessment of central obesity, taking into consideration adipose location, is more clinically useful than body mass index.

These findings may enable radiologists, when reporting abdominal CT, to notify the referring practitioner and allow for diabetic screening when intra-abdominal obesity is present.

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The authors

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