The severity of visceral obesity is associated with an increased risk of urolithiasis

OBJECTIVE To assess the relationship between urolithiasis and obesity related parameters measured by computed tomography (CT) abdominal scan. The relationships between visceral obesity and the severity of urinary stone disease, and between the severity of visceral obesity and urolithiasis were evaluated.

METHOD A retrospective case-control design was used, with one control subject for each patient, matched for age and sex. The participants were 100 adult patients with urolithiasis diagnosed by CT scan at our hospitals between October 2014 and September 2016. The control group consisted of 100 adults attending the hospital for trauma, with no past medical history of urological disease, who underwent abdominopelvic CT scan. The visceral fat area and other obesity related parameters were measured using the CT scan, on one cross-sectional cut at the level of the umbilicus.

RESULTS All the obesity related parameters were significantly higher in the urolithiasis group than in the control group. The largest effect size was in the mean visceral fat area, which was higher in the patient group with visceral obesity than in the control group with visceral obesity (p=0.03). No statistically significant relationship was found between visceral obesity and the severity of urinary stone disease.

CONCLUSIONS These results indicate that obesity, especially visceral obesity, is related to urinary stone disease. Individuals with severe obesity were at higher risk of urinary stone formation than individuals with mild obesity.

Key words
Computed tomography
Obesity
Severity
Visceral obesity
Urolithiasis

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Measurements

The total fat area (TFA), visceral fat area (VFA) and subcutaneous fat area (SFA) were measured on the CT abdominal scan on one cross-sectional cut at the level of the umbilicus. For measuring TFA, the threshold was determined with an attenuation range of -190 to -30 Hounsfield units.\(^6\) The fat area reserved within abdominal muscles was defined as VFA and the fat area reserved between abdominal muscles and skin was defined as SFA. Non-adipose areas, such as bowel contents, were excluded. Fat area was measured in square centimeters (cm\(^2\)). Figure 1 shows the objective data on the obesity related parameters.

The most common parts of non-fat area in the defined CT cut were muscles. The fat area to non-fat area ratio (FNR) was defined as the ratio of the amount of fat area to non-fat area on one cross-sectional cut at the level of the umbilicus. The definitions of the obesity parameters used in the study are shown in table 1.

The patients and control subjects were divided into two subgroups, with and without visceral obesity. The results of a previous study were considered to determine the cut-off points for the definition of visceral obesity.\(^7\) The cut-off point for VFA for men was 96 cm\(^2\) and for women 75 cm\(^2\). The VFA mean values of patients and control subjects with visceral obesity were compared to evaluate the relationship between urolithiasis and the severity of obesity. Based on a previous study, the multiplicity of stones and disease recurrence were considered as the markers of severity of urinary stone disease.\(^8\) The study was approved by the University Ethical Committee.

Statistical analysis

Independent samples t-test was used to compare the means. Effect sizes were calculated using Cohen’s d formula.\(^9\) Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS), version 15.0 (SPSS Inc, Chicago, IL). A p-value <0.05 was considered significant.

RESULTS

The mean age of the patients in the study group was 42.7±15.4 (range: 19–86) years, and of the subjects in the control group 42.6±15.7 (range: 19–88) years (p>0.05). The mean age of the men was 42.3±15.2 years in the study group and 42.3±15.3 years in the control group (p>0.05). The mean age of the women was 43.7±16.4 years in the study group, and 43.6±17.0 years in the control group (p>0.05).

All of the obesity related parameters were significantly higher in urinary stone group than in the control group. The largest effect size was in VFA, followed by FNR and TFA (tab. 2).

Visceral obesity was detected in 77 patients (58 men and 19 women) with urolithiasis, and 40 control subjects (30 men and 10 women). Significant differences were demonstrated in VFA between the two groups. The mean VFA was higher in patients with visceral obesity (173.4±61.8) than in the control subjects with visceral obesity (151.2±40.6). According to the study protocol, each patient had one matched control subject. Of the 77 patients with visceral obesity, 40 patients had a matched control subject with visceral obesity. Analysis of the data of these 40 cases and 40 matched control subjects revealed a significant difference in the VFA between the two groups (tab. 3). Regarding the

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**Figure 1.** Computed tomography (CT) imaging in visceral obesity: The left image shows the CT cut at the level of the umbilicus. In the right image, the black area shows the visceral fat area (VFA), the gray area shows the subcutaneous fat area (SFA) and the white area shows the non-fat area (NFR).

**Table 1.** Definitions of the fat measurement parameters used in the study.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total fat area (TFA)*</td>
<td>Area with fat attenuation in the selected computed tomography (CT) cut</td>
</tr>
<tr>
<td>Visceral fat area (VFA)*</td>
<td>Area with fat attenuation in the selected visceral part</td>
</tr>
<tr>
<td>Subcutaneous fat area (SFA)*</td>
<td>TFA subtracted from the VFA</td>
</tr>
<tr>
<td>Fat area to non-fat area ratio (NFR)</td>
<td>TFA/non-fat area</td>
</tr>
<tr>
<td>The percentage of VFA</td>
<td>(VFA/TFA)×100</td>
</tr>
<tr>
<td>Ratio of VFA to SFA</td>
<td>VFA/SFA</td>
</tr>
</tbody>
</table>

*Square centimeters (cm\(^2\))
clinical characteristics of the study patients, 35 (35%) were suffering from a single stone while 65 patients (65%) had multiple stones; 56 patients (56%) presented one episode, while 44 (44%) had recurrent disease. As shown in table 4, no significant relationship was detected between VFA and the parameters of severity.

**DISCUSSION**

The role of obesity and its various different aspects in urinary stone disease is ambiguous, although it is generally regarded as an accompanying factor. For this reason, specific obesity parameters measured on abdominal CT scan were evaluated in this study, to better clarify the possible role of obesity in stone formation and disease severity.

A few studies have focused on the relationship between visceral obesity and urinary stone disease. One recent study concluded that VFA and VFA% were significantly higher in patients with urolithiasis compared to a control group, while SFA was not significantly higher in patients with urolithiasis. The present study also indicated that VFA and VFA% were significantly higher in a group of patients with urinary stone disease than in a control group of matched subjects. In this study, however, the SFA also was significantly higher in patients with urinary stone disease than in the control subjects. The differences in the results of the two studies may be attributed to the selection of the control group. The earlier researchers selected for their control group individuals with flank pain but with no urinary stone identified by CT scan. It is therefore possible that patients who had passed out a urinary stone might have been included in the control group. In one previous study, SFA was found to be significantly higher in patients with the metabolic syndrome, and another study concluded that increase in VFA is a risk factor for urinary stone disease. In that study individuals without urinary stone disease who underwent CT scan were selected as control subjects. Thus, all other patients with diseases associated with visceral obesity were named as “controls”.

Based on the results of the present study, all the obesity related parameters measured were significantly higher in patients with urinary stone disease than in the control subjects. In addition, the largest effect size was related to VFA. The effect size shows the strength of a relationship.
Based on these results, the hypothesis that “obesity, especially visceral obesity, is related to urinary stone disease” is confirmed. A previous study found that body mass index (BMI) was not related to the severity of urolithiasis, as an independent variable. We used VFA rather than BMI as the index of obesity, but also found no significant relationship with the severity of urinary stone disease.

Another previous study concluded that obesity was associated with an increased risk of urolithiasis, although the risk of urolithiasis remained stable with increasing degrees of obesity. In the present study, VFA measured with CT scan rather than BMI was used to evaluate the severity of obesity. VFA is more precise than BMI in evaluation of the risk of the metabolic syndrome. According to the study data, an increase in VFA results in increasing stone formation, even in morbidly obese patients. It appears that individuals with severe obesity are at higher risk of urinary stone formation than those with mild obesity. Proteins or hormones related to the adipose cells, especially the visceral adipose cells may be considered as regulators of such effects.

In conclusion, visceral obesity, as a marker of the metabolic syndrome, had a significant relationship with urinary stone formation, but did not play an obvious role in the severity of urinary stone disease. In contrast with the results of a previous study, in our series, risk of stone formation was higher in the individuals with severe obesity than in those with mild obesity, which may be due to the selection of VFA, rather than BMI, as the marker of the severity of obesity.

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