Long-Term Effects of Low-Calorie Diet on the Metabolic Syndrome in Obese Nondiabetic Patients

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The prevalence of obesity is increasing among western populations, bringing about a parallel rise in the prevalence of the metabolic syndrome (1), which is strictly related to overweight (2). There is full agreement that lifestyle changes primarily focused on weight reduction are the first-line approach to patients with the metabolic syndrome (3). In short-term trials, even a modest weight reduction has been shown to favorably affect the components of the metabolic syndrome such as hypertension, lipid abnormalities, and glycemic control (4–8). The long-term effects of weight loss on the cluster of factors that comprise the metabolic syndrome is strictly related to overweight and each eligible participant gave written informed consent. We enrolled 41 patients (30 women and 11 men, age 58.7 ± 11.27 years [means ± SD]) with the metabolic syndrome as diagnosed according to the criteria of the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATPIII) (2). The inclusion criteria were age >18 years, BMI ≥30 kg/m², and a willingness to adhere to the prescribed diet. The exclusion criteria were a history of thyroid disease or diabetes, current pregnancy, an unstable medical condition, and the current use of medications known to affect weight, appetite, and/or blood lipids. Patients on antihypertensive therapy maintained a stable medical regimen throughout the study. All patients were prescribed a low-calorie diet tailored to provide an ~500-calorie/day deficit based on their estimated daily energy expenditure (11). The diet was modeled after the NCEP ATPIII diet (2) and provided 30% of energy from fat (<7% from saturated fat), 55% from carbohydrates, and 15% from protein, with <200 mg cholesterol/day. The fiber content ranged from 20 to 30 g. The patients were also encouraged to increase their physical activity, preferably by aerobic activities (12). After the initial visit, the patients met in monthly group sessions for 4 months and were then seen in three to four follow-up visits per year for the next 20 months. Laboratory values were measured in the hospital laboratory by standard methods. For each variable, differences between basal conditions and follow-up were assessed using Student’s t test for paired data. χ² Test was used to compare discrete variables.

RESULTS — At the beginning of the study, all 41 patients had abdominal obesity, 39 (95%) were hypertensive, 26 (63%) had low HDL cholesterol, 22 (54%) had high triglycerides, and 17 (41%) had high blood glucose. The most common triad of metabolic syndrome components was abdominal obesity, hypertension, and low HDL cholesterol (59%). Body weight decreased by 8.5% after 6 months and was 9.9% lower than baseline (range +6 to −39%) at the end of the study. After 2 years, all of the components of the metabolic syndrome underwent a highly significant improvement (Table 1). HDL cholesterol normalized in 8 of 26 patients, serum triglycerides fell below 150 mg/dl in 5 of 22 patients, blood pressure ceased to be elevated in 7 of 39 patients, waist girth decreased to a fasting level of blood glucose <100 mg/dl at the end of the study.

Because of the improvement of one component (6 patients) or more (9 patients) of the metabolic syndrome at the end of the study, 15 patients (37%) no longer fulfilled the criteria for the metabolic syndrome. Patients who lost >10% of initial body weight (n = 15, mean −18.1 ± 8.55%) experienced greater reduction in the number of components of the metabolic syndrome than patients who lost <10% (n = 26, mean −3.9 ± 3.61%). At the end of the 2nd year, 10 patients in the first group (66%) and 5 in the second group (19%) ceased to fulfill the criteria for the metabolic syndrome (χ² 11.384, P < 0.001).

CONCLUSIONS — In this study, the metabolic syndrome was effectively treated by long-term diet and lifestyle therapy alone in 37% of obese, nondiabetic patients. Our diet was low in fat, relatively rich in carbohydrates and fiber, and closely resembled the NCEP ATPIII—
Effects of diet on the metabolic syndrome

Table 1—Mean component values of the metabolic syndrome at baseline and after 2 years of low-calorie diet

<table>
<thead>
<tr>
<th>Component</th>
<th>Baseline</th>
<th>2 years</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI (kg/m²)</td>
<td>37.6 ± 5.63</td>
<td>34.0 ± 5.45</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>93.1 ± 18.17</td>
<td>83.9 ± 14.33</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>110.3 ± 12.30</td>
<td>102.6 ± 10.70</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Serum triglycerides (mg/dl)</td>
<td>163.2 ± 69.32</td>
<td>132.8 ± 51.98</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>HDL cholesterol (mg/dl)</td>
<td>46.3 ± 11.10</td>
<td>52.8 ± 15.66</td>
<td>0.003</td>
</tr>
<tr>
<td>Blood glucose (mg/dl)</td>
<td>108.0 ± 17.90</td>
<td>101.5 ± 17.76</td>
<td>0.004</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)*</td>
<td>143.2 ± 19.68</td>
<td>133.9 ± 16.13</td>
<td>0.003</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)*</td>
<td>84.2 ± 9.74</td>
<td>75.9 ± 10.90</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Data are means ± SD. *Twenty-three patients were on constant hypotensive drug therapy during the overall period of the study.

recommended diet. Resolution of the metabolic syndrome was achieved in two-thirds of patients, who achieved a weight loss of at least 10% over 2 years, whereas in patients who lost <10%, the prevalence of the metabolic syndrome remained high (81%). However, all of the patients in whom the metabolic syndrome resolved remained obese (BMI >30 kg/m²) at the end of the study. Our results therefore confirm, in a typical clinical setting, the usefulness of weight loss in obese patients for resolving the metabolic syndrome, and they support the view that obese patients need not achieve ideal body weight to improve their metabolic profile (3).

The macronutrient composition of diet, not just the caloric deficit, may be important in the management of the metabolic syndrome. For example, diets high in carbohydrates may have detrimental effects on blood glucose, triglycerides, and HDL cholesterol (14,15). However, in our study, which utilized a relatively high-carbohydrate diet, we observed no cases of worsening blood glucose, triglycerides, or HDL cholesterol. On the contrary, these all improved significantly after 2 years of diet. In particular, blood glucose fell by 6% on average and normalized in 35% of patients with impaired fasting blood glucose (13) at baseline, suggesting that a relatively high-carbohydrate diet is safe in patients at risk of developing diabetes, at least when associated with body weight loss. In conclusion, a diet consistent with NCEP ATP III recommendations with only a modest reduction in calories is effective in the long-term management of the metabolic syndrome in obese nondiabetic patients, particularly in those who achieve a body weight reduction >10%. However, whether their risk for developing coronary heart disease and/or diabetes has been lowered simply because they no longer meet the criteria for the metabolic syndrome remains to be documented.

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References
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