Circulating leptin levels in juvenile idiopathic arthritis: a marker of nutritional status?

F Perfetto, R Tarquini, G Simonini, GBindi, F Mancuso, S Guiducci, M Matucci-Cerinic, F Falcini

Background: Weight loss is common in juvenile idiopathic arthritis (JIA) and has been positively correlated with an increase in the production of proinflammatory cytokines.

Objective: To assess if plasma leptin is a mediator of cytokine dependent decreased food intake during inflammatory diseases and if it is increased in JIA.

Methods: Leptin levels were determined in 31 patients with polyarticular disease and in 37 with oligoarticular disease; 32 healthy children served as controls.

Results: Patients had significantly reduced body mass index (BMI) compared with controls (17.3 (3) v 19.1 (3) kg/m²; p<0.005). Leptin was significantly lower in patients than controls (8.1 (4.8) v 10.7 (7.3) ng/ml; p = 0.036), but leptin/BMI values were similar. Absolute (8.2 (4.8) v 8 (4.9); p>0.05) and normalised (0.45 (0.24) v 0.47 (0.24); p>0.05) leptin levels were not significantly different between patients with active and inactive disease and between patients with oligoarticular and polyarticular arthritis (7.8 (4.4) v 8.6 (5.3); p>0.05 and 0.45 (0.23) v 0.48 (0.26); p>0.05, respectively).

Conclusions: Leptin production per unit of fat mass is similar in patients and controls. The hypothesis that high levels of proinflammatory cytokines that characterise JIA might induce an increase of adipocytokine leptin production is not supported by the results. Leptin may be a marker of nutritional status of JIA.
We found similar absolute and relative leptin concentrations in patients with active and inactive disease (8.2 (4.8) v 8 (4.9) and 0.45 (0.24) v 0.47 (0.24), respectively; p, 0.05 for both) and in children with oligoarticular and polyarticular disease (7.8 (4.4) v 8.6 (5.3) and 0.45 (0.23) v 0.48 (0.26), respectively; p, NS, table 2).

Patients treated with MTX showed similar absolute (8.7 (5.4) v 7.7 (4.5); p>0.05) and relative leptin concentrations (0.49 (0.26) v 0.44 (0.23) p>0.05) to those of patients not treated with MTX. Girls showed significantly higher leptin concentrations than boys (in patients: 9.1 (5) v 6.6 (4.1) ng/ml, p<0.05; in controls: 12.7 (7.9) v 7 (4.1) ng/ml, p<0.03). These differences were amplified when leptin values were adjusted for BMI (in patients: 0.52 (0.25) v 0.36 (0.19) (ng/ml)/(kg/m²), p<0.008; in controls: 0.63 (0.30) v 0.36 (0.17) (ng/ml)/(kg/m²), p<0.009).

Leptin concentration correlated positively with BMI in patients and controls (r = 0.552 and r = 0.744, respectively; p<0.0001 for both). In patients, leptin correlated positively also with age (r = 0.407, p<0.0005). Multiple regression analysis indicated that BMI together with sex (p<0.001 for both) were the best predictors of circulating leptin in patients, accounting for 66% of its variance. Some other measures (disease activity and MTX treatment) could be included in the model without a significant change in its strength. In controls, BMI, sex, and age were the best predictors of circulating leptin, accounting for 81% of its variance.

**DISCUSSION**

This study indicates that leptin production per unit of fat mass is similar in patients with JIA and controls and that the lower BMI found in patients with JIA could account for their low circulating leptin concentrations. Moreover, multiple regression analysis showed that neither the activity of the disease nor the type of onset of disease correlated with circulating leptin concentrations. In agreement with published reports, BMI and sex were the most important independent predictors of plasma leptin levels in patients and controls. Thus, the hypothesis that leptin might be the mediator of anorexia and weight loss in JIA, is not supported by our results. Few studies have examined the correlation between leptin and rheumatic disease and, to date, this is the first report on leptin in JIA.
In patients with rheumatoid arthritis (RA), leptin concentrations were found to be similar to those of healthy controls and were unrelated to disease activity. Bokarewa et al reported that leptin plasma levels were significantly higher than leptin concentrations in RA matched synovial fluid samples. Plasma and synovial fluid leptin were significantly correlated, but had no relationship with age, sex, and disease duration. Furthermore, patients with non erosive arthritis had lower leptin concentrations in synovial fluid, suggesting an in situ consumption of this peptide. They concluded that intra-articular leptin might exert a protective effect against the destructive course of RA.

Although leptin levels were reported to be higher in patients with systemic lupus erythematosus than in controls, leptin did not correlate with disease activity index, whereas a positive relationship was found in patients with Behcet’s disease. As suggested by Palmer and Gabay in a recent review of the role of leptin in rheumatic diseases, these data indicate that leptin cannot be used to assess disease activity in RA and systemic lupus erythematosus.

Our data are consistent with reports that failed to show increased leptin concentrations in chronic human cytokine mediated disorders such as HIV infection, inflammatory bowel disease, and neoplastic cachexia. In all these inflammatory diseases, plasma leptin concentrations correlated strongly with BMI.

The finding that in our patients low leptin concentrations were not reflected by an increase in body weight may suggest that the hypothalamus is insensitive to low circulating leptin concentrations and that the normal homeostatic mechanism that protects body weight against losses has been overridden. A similar mechanism has been proposed by Inui for the pathophysiology of the cancer anorexia-cachexia syndrome. The mechanism of this hypothalamic insensitivity to low circulating leptin levels is not clear, but there is evidence that proinflammatory cytokines may mimic the hypothalamic effect of excessive negative feedback signalling from leptin, leading to the prevention of the normal compensatory mechanisms in the face of both decreased food intake and decreased body weight. This appears to be a likely explanation because the leptin receptor is homologous to the gp130 signal transducing molecule associated with the IL6-type cytokine receptor and shares the same post-receptor signalling pathway via activation of the signal transducers and activators of the transcription family, mainly through stat 3 protein activation. Therefore, as stat 3 protein is essential for leptin induced anorexia, the cytokines that share with leptin the same post-receptor signalling pathway could likewise induce anorexia and unopposed weight loss.

In agreement with published reports, girls had higher leptin concentrations than boys despite having similar BMIs. The reason for this difference between the sexes is unclear, but several studies report that girls’ fat cells produce more leptin than those of boys with a similar body mass. In conclusion, our results suggest that weight loss in JIA is not due to an increase in leptin levels. In JIA, circulating leptin levels that are merely a function of the amount of body fat do not reflect disease activity but may be a biochemical marker of patient nutritional status. Further longitudinal studies elucidating the interaction between leptin, proinflammatory cytokines, and acute phase proteins might provide important insights into the pathways involved in energy balance regulation and anorexia in JIA.

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**Table 2** Clinical characteristics and serum leptin levels of 68 children with oligoarticular and polyarticular juvenile idiopathic arthritis (JIA)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Oligoarticular JIA</th>
<th>Polyarticular JIA</th>
<th>p Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>9.1 ± 4.2</td>
<td>9.6 ± 4.7</td>
<td>NS</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.30 ± 0.22</td>
<td>1.27 ± 0.24</td>
<td>NS</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>30.8 ± 14.4</td>
<td>30.4 ± 15.9</td>
<td>NS</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>17.2 ± 2.6</td>
<td>17.4 ± 3.4</td>
<td>NS</td>
</tr>
<tr>
<td>Leptin (ng/ml)</td>
<td>7.8 ± 4.4</td>
<td>8.6 ± 5.3</td>
<td>NS</td>
</tr>
<tr>
<td>Leptin /BMI ((ng/ml)/ (kg/m²))</td>
<td>0.45 ± 0.23</td>
<td>0.48 ± 0.26</td>
<td>NS</td>
</tr>
</tbody>
</table>

Results are shown as mean (SD).
REFERENCES
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