RS3PE syndrome presenting as vascular endothelial growth factor associated disorder

K Arima, T Origuchi, M Tamai, N Iwanaga, Y Izumi, M Huang, F Tanaka, M Kamachi, K Aratake, H Nakamura, H Ida, M Uetani, A Kawakami, K Eguchi

Objectives: To characterise serum concentrations of various cytokines and detection by magnetic resonance imaging (MRI) of synovial hypervascularity in patients with remitting seronegative symmetrical synovitis with pitting oedema (RS3PE) syndrome before and after corticosteroid treatment.

Methods: Vascular endothelial growth factor (VEGF), tumour necrosis factor-α (TNF-α), and interleukin 1β (IL1β) were measured by enzyme linked immunosorbent assay (ELISA) in serum samples from three patients with RS3PE syndrome. As controls, serum samples from 26 healthy volunteers, 12 patients with rheumatoid arthritis, 10 patients with systemic lupus erythematosus, 13 patients with polymyositis/dermatomyositis, 13 patients with vasculitis syndrome, and 6 patients with mixed connective tissue disease were also analysed. Synovial hypervascularity of patients with RS3PE syndrome was estimated by rate of enhancement (E-rate) in a dynamic MRI study.

Results: Serum concentrations of VEGF (mean (SD) 2223.3 (156.3) pg/ml) were significantly higher in patients with active RS3PE syndrome than in controls before corticosteroid treatment. TNF-α and IL1β levels were similar in patients and controls. Synovial hypervascularity in affected joints and subcutaneous oedema decreased during corticosteroid treatment, in parallel with the fall in serum VEGF165. Conclusions: VEGF promotes synovial inflammation and vascular permeability in patients with RS3PE syndrome, suggesting that RS3PE can be classified as a VEGF associated disorder.

PATIENTS AND METHODS

Patients

Serum samples were obtained from three patients with typical manifestations of RS3PE syndrome. As controls, serum samples from 26 healthy volunteers, 12 patients with rheumatoid arthritis, 10 patients with systemic lupus erythematosus, 13 patients with polymyositis/dermatomyositis, 13 patients with vasculitis syndrome, and 6 patients with mixed connective tissue disease were analysed. Informed consent was obtained from each patient, and the study was approved by the Institutional Review Board of Nagasaki University.

Enzyme linked immunosorbent assay

Serum concentrations of VEGF165 (major isoform of VEGF) as well as those of tumour necrosis factor-α (TNF-α) and interleukin 1β (IL1β) in the above subjects were analysed by enzyme linked immunosorbent assay (ELISA; VEGF165, R&D Systems, Inc, Minneapolis, MN, USA; TNF-α, BioSource Europe SA, Nivelles Belgium; IL1β, Amersham Biosciences, Buckinghamshire, UK).

Dynamic magnetic resonance imaging (MRI)

MRI of both wrists and finger joints was carried out simultaneously using a 1.5 T system (Sigma, GE Medical Systems, Milwaukie, WI, USA) with the use of an extremity coil. Coronal T1 weighted spin echo (repetition time (TR) 450, echo delay time (TE) 13) and short time inversion recovery (STIR) (TR 3000, TE 12, T1 160) images were acquired. Dynamic study data were obtained at 4 second intervals for 150 seconds with fast spoiled gradient echo recalled (SPGR) sequences after intravenous injection of 0.1 mmol/kg of gadolinium-diethylenetriamine (Magnevist, Schering, Germany). Post-contrast, fat suppressed T2 weighted images (TR 600, TE 13) were acquired in axial and coronal planes after completion of the dynamic study.

Images were evaluated for the presence or absence of synovitis in 15 joints in each wrist and finger joint—that is, distal radioulnar joint, radiocarpal joint, mid-carpal joint, 1st carpometacarpal joint, 2nd–5th carpometacarpal joints (together), 1st–5th metacarpophalangeal joints separately, and 1st–5th proximal interphalangeal joints separately. A dynamic curve was obtained by plotting signal intensity against time in a round region measuring approximately 2–3 mm placed on the site of maximum enhancement in the aforementioned 15 joints. The rate of enhancement (E-rate) was defined as the rate of increase in signal intensity over the...
steep linear region of the curve and was used as a measure of hypervascularity of the tissue.

**Statistical analysis**

Data were expressed as mean (SD). Statistical analysis was performed using Student's t test. Values of p<0.05 were considered significant.

**RESULTS**

**Serum concentrations of cytokines**

Table 1 summarises the serum concentrations of VEGF-A, TNFα, and IL1β in various connective tissue diseases. As shown in table 1, no significant differences in TNFα and IL1β serum concentrations were noted between RS3PE syndrome and other connective tissue diseases; however, markedly high serum VEGF165 levels were found in patients with RS3PE syndrome. Because VEGF165 serum concentrations in other connective tissue diseases were comparable with those found in previous reports,78 the high concentrations in other connective tissue diseases were in patients with RS3PE syndrome. Because VEGF165 serum concentrations in these subjects were also not detected in serum samples from healthy volunteers (data not shown), and serum concentrations of VEGF165 in these subjects were also low (data not shown).

**MRI in patients with RS3PE syndrome**

Table 2 shows the mean E-rate of 30 joints (both wrists and finger joints) in three patients with RS3PE syndrome before and after 1 month of corticosteroid treatment. Synovial hypervascularity determined by the E-rate was reduced by corticosteroid treatment in all the three patients in parallel with the fall of serum VEGF (table 1). Subcutaneous oedema shown by a STIR image was also reduced after corticosteroid treatment in each patient with RS3PE syndrome (data not shown).

**DISSCUSSION**

VEGF is a potent angiogenic,9 10 vasoactive,11 molecule which increases permeability,11 12 first described by Senger et al in 1983.13 They partially purified a factor secreted by hepatocarcinoma cell lines that increased dye extravasations into the skin of guinea pigs. In addition, recent studies reported that serum VEGF concentrations, although not as high as RS3PE syndrome found in the present cases, correlate with disease activity in patients with inflammatory arthropathies such as rheumatoid arthritis.7 14

The pathogenic mechanism of RS3PE syndrome is still unknown. As far as we know, this is the first report indicating that VEGF may contribute to the pathological changes seen in patients with RS3PE syndrome: both synovial hypervascularity (synovitis) and increment of vascular permeability (subcutaneous oedema) may be facilitated by VEGF in patients with RS3PE syndrome. Serum VEGF165 levels were selectively high in active RS3PE syndrome as compared with other connective tissue diseases. This difference of serum VEGF165 may be due to the difference of corticosteroid dosage among patient groups, and we cannot exclude the possibility at present that high serum VEGF165 concentrations in RS3PE syndrome may be a consequence of in vitro platelet activation in serum.15 However, our consecutive analysis of VEGF165 as well as MRI suggests that serum VEGF might be useful for the diagnosis and monitoring of disease activity in patients with RS3PE syndrome.

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### Table 1 Serum concentrations of VEGF-A, TNFα, and IL1β in various connective tissue diseases

<table>
<thead>
<tr>
<th>Connective tissue disease</th>
<th>VEGF-A (pg/ml)</th>
<th>TNFα (pg/ml)</th>
<th>IL1β (pg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS3PE syndrome (n = 3)</td>
<td>2223.3 (156.3)</td>
<td>26.3 (20.8)</td>
<td>0.67 (0.81)</td>
</tr>
<tr>
<td>RA (n = 12)</td>
<td>711.0 (401.7)</td>
<td>19.9 (13.7)</td>
<td>0.61 (0.39)</td>
</tr>
<tr>
<td>SLE (n = 10)</td>
<td>309.9 (140.6)</td>
<td>34.2 (19.4)</td>
<td>0.32 (0.16)</td>
</tr>
<tr>
<td>MCTD (n = 6)</td>
<td>682.3 (575.0)</td>
<td>51.8 (27.7)</td>
<td>0.48 (0.39)</td>
</tr>
<tr>
<td>PM/DM (n = 13)</td>
<td>324.2 (188.9)</td>
<td>22.6 (10.9)</td>
<td>0.32 (0.24)</td>
</tr>
<tr>
<td>Vasculitis syndrome (n = 13)</td>
<td>736.1 (475.5)</td>
<td>27.3 (14.2)</td>
<td>0.90 (1.38)</td>
</tr>
</tbody>
</table>

RS3PE syndrome, remitting seronegative symmetrical synovitis with pitting oedema syndrome; RA, rheumatoid arthritis; SLE, systemic lupus erythematosus; MCTD, mixed connective tissue disease; PM/DM, polymyositis/dermatomyositis.

Data are mean (SD) of the indicated number of patients.

*p<0.0001 v other connective tissue diseases by Student’s t test.

### Table 2 Serum concentrations of VEGF165 and E-rate of dynamic MRI during corticosteroid treatment

<table>
<thead>
<tr>
<th>Patient No</th>
<th>VEGF165 (pg/ml)</th>
<th>Mean (SD) inhibition (%)</th>
<th>E-rate</th>
<th>Mean (SD) inhibition (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before treatment</td>
<td>After treatment</td>
<td>Before treatment</td>
<td>After treatment</td>
</tr>
<tr>
<td>1</td>
<td>2341</td>
<td>393</td>
<td>19.6</td>
<td>10.9</td>
</tr>
<tr>
<td>2</td>
<td>2283</td>
<td>605</td>
<td>15.4</td>
<td>10.7</td>
</tr>
<tr>
<td>3</td>
<td>2046</td>
<td>1516</td>
<td>9.7</td>
<td>7.8</td>
</tr>
</tbody>
</table>

*p=0.037 and tp=0.024 v before corticosteroid treatment by Student’s t test.
REFERENCES

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