**EXTENDED REPORT**

Infectious CNS disease as a differential diagnosis in systemic rheumatic diseases: three case reports and a review of the literature

K Warnatz, H H Peter, M Schumacher, L Wiese, A Prasse, F Petschner, P Vaith, B Volk, S M Weiner

**Background:** Immunosuppressive treatment of rheumatic diseases may be associated with several opportunistic infections of the brain. The differentiation between primary central nervous system (CNS) involvement and CNS infection may be difficult, leading to delayed diagnosis.

**Objective:** To differentiate between CNS involvement and CNS infection in systemic rheumatic diseases.

**Methods and results:** Three patients with either longstanding or suspected systemic rheumatic diseases (systemic lupus erythematosus, Wegener’s granulomatosis, and cerebral vasculitis) who presented with various neuropsychiatric symptoms are described. All three patients were pretreated with different immuno-suppressive drugs (leflunomide, methotrexate, cyclophosphamide) in combination with corticosteroids. Magnetic resonance imaging of the brain was suggestive of infectious disease, which was confirmed by cerebrospinal fluid analysis or stereotactic brain biopsy (progressive multifocal leukoencephalopathy [PML] in two and nocardiosis in one patient).

**Discussion:** More than 20 cases of PML or cerebral nocardiosis in patients receiving corticosteroids and cytotoxic drugs for rheumatic disease have been reported. The clinical aspects of opportunistic CNS infections and the role of brain imaging, cerebrospinal fluid analysis and stereotactic brain biopsy in the differential diagnosis are reviewed.

Central nervous system (CNS) involvement may become a severe complication of several autoimmune disorders. In systemic lupus erythematosus (SLE) between 18 and 67% of patients have CNS involvement. Symptoms include psychosis, mood disorders, seizures, acute confusional states, stroke, migraine, chorea, aseptic meningitis, transverse myelopathy, as well as subtle cognitive impairment. There are no specific laboratory or magnetic resonance imaging (MRI) findings, making a proper diagnosis often difficult. MRI may be negative despite overt neuropsychiatric symptoms.

Cerebrospinal fluid (CSF) analyses may show mild lymphocytic pleocytosis, raised protein levels, and IgG indices as well as oligoclonal bands in 25–50% of cases. In up to 81% of the cases CNS lupus may occur without systemic SLE activity, often leading to a delayed diagnosis.

In Wegener’s granulomatosis (WG) cerebral involvement is rare (2–8%). Forty years ago a review by Drachman described three patterns of CNS involvement in WG: (a) vasculitic changes; (b) meningeal involvement due to adjacent granulomatous disease; and (c) isolated granulomatous meningocebral lesions. In recent MRI studies Murphy et al reported about 30% meningeal thickening and contrast enhancement, 26% meningeal involvement by extracerebral granulomatous disease, 20% cerebral infarcts, and about 50% non-specific white matter lesions. The main clinical manifestations are headache, seizure, or loss of function owing to focal lesion and stroke. Usually the diagnosis of WG is well established before CNS involvement occurs. There are no specific findings in WG suggesting CNS involvement. CSF analysis often shows only a slight rise in protein and a mild lymphocytic pleocytosis. The diagnosis is made by clinical findings, MRI of the CNS, and histology.

Primary angiitis of the CNS is a very rare disorder. The diagnosis is based on the presence of neurological dysfunction, angiographic features of vasculitides (vessel irregularity, aneurysms, stenosis) and, if possible, stereotactic biopsy. MRI findings include infarction and white matter lesions, but both are non-specific. The diagnosis of this entity remains problematic and requires the exclusion of more common conditions. Other autoimmune diseases with common CNS involvement include polyarteritis nodosa, antiphospholipid antibody syndrome, and Behçet’s disease.

Chronic dysregulation of the immune system in conjunction with immunosuppressive treatment predisposes patients with systemic autoimmune diseases to infections. Therefore the new onset of CNS symptoms always leads to the suspicion of underlying infections in the differential diagnosis of these patients.

Several viruses, bacteria, and fungi can imitate the clinical and the radiological picture of CNS involvement of the primary autoimmune diseases. Therefore careful evaluation of the CNS manifestation is essential because the impact on the therapeutic decision is great. However, the diagnostic procedure is limited by time because in all patients with severe CNS involvement prompt treatment should be instituted in order to preserve the maximum of cerebral function. In this paper we report the cases of three patients with infectious CNS involvement mimicking autoimmune disorders. We also review the literature and suggest a standard diagnostic procedure in these cases.

**Abbreviations:** ANA, antinuclear antibodies; ANCA, antineutrophil cytoplasmic antibodies; CMV, cytomegalovirus; CNS, central nervous system; CRP, C reactive protein; CSF, cerebrospinal fluid; EBV, Epstein-Barr virus; HIV, human immunodeficiency virus; HSV, herpes simplex virus; IV, intravenous; MRI, magnetic resonance imaging; PCR, polymerase chain reaction; PML, progressive multifocal leukoencephalopathy; SLE, systemic lupus erythematosus; VZV, varicella zoster virus; WG, Wegener’s granulomatosis
The number of CD8+ T cells was decreased (0.24 × 10^9/l) against dsDNA were positive, CH50 was not decreased, but C3d and the CD4/CD8 ratio (2.81; normal range 1.4–2.4). Antibodies against dsDNA were positive, CH50 was not decreased, but C3d and the CD4/CD8 ratio (2.81; normal range 1.4–2.4).

Lesions of the right temporal region were visible. The lesions consisted of phases of progression followed by phases of clear improvement of the neurological deficits.

CASE REPORTS

Patient 1

A 33 year old woman was admitted to our hospital with progressive personality alterations, impairment of concentration and memory, difficulties in word finding, headache, and dysarthria. Eleven years ago SLE was diagnosed by the presence of antinuclear antibodies (titre 1/6000), increased DNA binding, photosensitivity, aphthosis, Jaccoud's arthritis, anaemia, and leucopenia. She had been treated with prednisone doses adjusted to disease activity (7.5–25 mg) and various immunosuppressive drugs: initially, azathioprine; later, chloroquine, danazol, cyclosporin A; and, finally, methotrexate. Five suppressive drugs: initially, azathioprine; later, chloroquine, danazol, cyclosporin A; and, finally, methotrexate. Five suppressive drugs: initially, azathioprine; later, chloroquine, danazol, cyclosporin A; and, finally, methotrexate.

On admission, laboratory analysis showed a moderate leucopenia (3.2–4.2 × 10^9/l) with lymphocytopenia (0.7–1.0 × 10^9/l). The number of CD8+ T cells was decreased (0.24 × 10^9/l); normal range 0.31–0.53 × 10^9/l), resulting in a slightly raised CD4/CD8 ratio (2.81; normal range 1.4–2.4). Antibodies against dsDNA were positive, CH50 was not decreased, but C3d was slightly raised (10.6 mg/l); normal range <10). T, weighted MRI of the brain showed confluent, hyperintense, white matter lesions of the left sided frontotemporal and high parietal region and the right sided supraventricular region (fig 1A). In addition, spotted hyperintense lesions of the left sided thalamus, basal ganglia, capsula interna, and scattered white matter lesions of the right temporal region were visible. The lesions were not enhanced by gadolinium-DTPA and had low signal intensity on T1 weighted imaging. CSF analysis showed a normal cell count, an increased total protein content (652 mg/l), an IgG index of 0.5, and positive oligoclonal bands. A stereotactic brain biopsy was performed that showed abnormal oligodendroglial cells, demyelination, and swollen astrocytes associated with inflammatory cell infiltrates, suggesting the diagnosis of progressive multifocal leucoencephalopathy (PML). The diagnosis was confirmed by electron microscopy (fig 1B) and the detection of JC virus DNA in the brain tissue (nested polymerase chain reaction (PCR)) and in CSF samples (quantitative PCR). Tests for human immunodeficiency virus (HIV), cytomegalovirus (CMV) antigen, CMV-RNA, and antitoxoplasma IgM antibodies were negative. Leflunomide was stopped and the drug elimination was hastened by a two week treatment with cholestyramine.

Within three weeks the neurological status worsened, leading to a progressive motor weakness of the right side, a central paresis of the facial nerve, and a central impairment of bladder function. An MRI follow up disclosed progressive brain lesions. Antiviral treatment was started with 5 mg/kg cidofovir every two weeks. The course of the disease was fluctuating with phases of progression followed by phases of clear improvement of the neurological deficits.

Patient 2

Four years before admission a 52 year old white man had been diagnosed with WG. After a new onset of haemoptysis, proteinuria, scleritis, and arthralgias, diagnosis was histologically proved by a necrotising, granulomatous vasculitis in a bronchial biopsy specimen and a positive CANCA (titre 1/100, anti-PR3 positive). With oral cyclophosphamide (2 mg/kg body weight) the clinical course stabilised, except for a residual proteinuria of 0.5 g/day. After 29 months of cyclophosphamide treatment (total dose 95 g), treatment was changed to methotrexate. Two months before admission, a slight increase in arthralgias and fever had developed. Because of suspected WG relapse the treating family doctor increased the daily steroid dose to 50 mg prednisolone a day. The patient was then admitted to our hospital. Because physical examination, a computed tomography scan of the lungs, and laboratory investigations showed no signs of WG activity or of infection, the patient was discharged and tapering of prednisolone was recommended.

Three weeks later he was readmitted because of cough, fever, night sweats, and weight loss of 8 kg. Now, the C reactive protein (CRP) was raised (24 g/l) and the differential blood count showed a lymphocytopenia, with CD4+ T cell counts reduced to 0.2 × 10^9/l. An initial chest x ray examination, bronchoscopy, and blood cultures failed to identify any pathogens. Subsequently, the carbon monoxide diffusion capacity was decreased and a new chest x ray examination led to a suspicion of interstitial pneumonia. A bronchoalveolar lavage was performed and showed a chronic inflammation with no signs of pulmonary haemorrhage. All bacterial cultures, PCR for tuberculosis, legionella, and chlamydia, and PCR for Herpes viruses (herpes simplex virus (HSV), CMV, Epstein-Barr virus (EBV)) were negative. Treatment with methotrexate (15 mg weekly) was stopped and a third class cephalosporin and clarithromycin were started. Because the pulmonary function deteriorated, clarithromycin was changed to intravenous Pneumocystis carinii pneumonia.

Within three weeks the neurological status worsened, leading to a progressive motor weakness of the right side, a central paresis of the facial nerve, and a central impairment of bladder function. An MRI follow up disclosed progressive brain lesions. Antiviral treatment was started with 5 mg/kg cidofovir every two weeks. The course of the disease was fluctuating with phases of progression followed by phases of clear improvement of the neurological deficits.

Figure 1  [A] Coronal MRI scan of the brain showing confluent foci (arrows) of hyperintensity in the deep and subcortical white matter and subdural space on inversion recovery sequences (patient 1). [B] Electron micrograph of a brain biopsy specimen (patient 1): Nucleus of a transformed oligodendrocyte with multiple electron dense particles typical for polyoma viruses (arrow). Magnification ×66 300.
weighted images (fig 2B). As serological tests for toxoplasma IgM, aspergillus, borrelia, varicella zoster virus (VZV) IgA, CMV IgM, HSV, HIV were still negative, a stereotactic brain biopsy was performed. Pathological examination showed non-specific inflammation, but microscopic evaluation suggested coryne-like bacteria; the culture confirmed *Nocardia farcinica*. Intravenous co-trimoxazole, the preferred treatment, was continued for 40 days and then switched to oral maintenance treatment. A control MRI scan of the brain showed a complete remission six months later and clinically there was no WG activity detectable despite discontinuation of methotrexate.

Unfortunately, one year later the patient presented with proteinuria (6 g/day) and histological signs of segmental glomerulonephritis. The patient was treated with mycophenolate (1000 mg/day) without recurrence of the nocardia infection during the three month follow up.

**Patient 3**

A 55 year old white man complained of difficulties in writing four months before admission. His previous medical history was unremarkable. As the following neurological examinations, including EEG and MRI of the brain, were without clearcut pathological findings, the initial stage of Parkinson's disease was suspected. MRI of the brain was repeated six months later and clinically there was no WG activity detectable despite discontinuation of methotrexate.

On admission an MRI scan of the brain showed multiple confluent non-enhancing lesions of the periventricular, subcortical, and deep white matter with discrete involvement of the cortex (fig 3A). The diffusion weighted MRI scan showed increased diffusion of the brain lesions (fig 3B). Further examinations showed no underlying autoimmune process (negative results for rheumatoid factor, antinuclear antibodies (ANA), antineutrophil cytoplasmic antibodies (ANCA), antiphospholipid antibodies) or embolic disease. Laboratory findings, including CRP values, were unremarkable with the exception of a steroid induced leucocytosis of $23.5 \times 10^9/l$ (13% lymphocytes) and a mild hypogammaglobulinaemia (IgG 5.6 g/l, normal range 7–16; IgA 0.6 g/l, normal range 0.7–4). Because of the impression of an accelerated deterioration of the underlying disease cyclophosphamide pulse therapy was started. The patient felt some improvement and was discharged one week later to rehabilitation.

One month later, after the patient had received a second bolus of cyclophosphamide, he became febrile, somnolent, and tetraparetic. On readmission, an MRI scan of the brain showed progressive confluent non-enhancing subcortical white matter lesions. A spinal tab was repeated and the CSF was positive for JC viral DNA. Before treatment could be applied he died with signs of septic shock.
Table 1  Clinical presentation of primary cerebral involvement of rheumatic diseases and opportunistic CNS infections

<table>
<thead>
<tr>
<th>Clinical presentation</th>
<th>NPSLE</th>
<th>Primary CNS vasculitis</th>
<th>Wegener’s granulomatosis</th>
<th>Neuro-Behçet</th>
<th>Neurosarcoidosis</th>
<th>PML</th>
<th>HSV encephalitis</th>
<th>Bacterial meningitis</th>
<th>Brain abscess</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset of CNS disease</td>
<td>Acute, subacute, chronic</td>
<td>Acute, subacute, chronic</td>
<td>Subacute, chronic</td>
<td>Acute, subacute, chronic</td>
<td>Acute, subacute, chronic</td>
<td>Subacute (weeks)</td>
<td>Acute, subacute (days-weeks)</td>
<td>Acute (days)</td>
<td>Subacute (days-weeks)</td>
</tr>
<tr>
<td>Seizures</td>
<td>13–35%</td>
<td>15–20%</td>
<td>Rare</td>
<td>4%</td>
<td>10%</td>
<td>5%</td>
<td>Frequent</td>
<td>20–30%</td>
<td>20–30%</td>
</tr>
<tr>
<td>Headache</td>
<td>34–57%</td>
<td>30–64%</td>
<td>Frequent</td>
<td>95%</td>
<td>30%</td>
<td>5%</td>
<td>Frequent</td>
<td>90%</td>
<td>70–90%</td>
</tr>
<tr>
<td>Motor weakness/paralysis</td>
<td>20%</td>
<td>50%</td>
<td>?</td>
<td>10–21%</td>
<td>24%</td>
<td>Pyramidal signs</td>
<td>5–10%</td>
<td>Frequent</td>
<td>10–15%</td>
</tr>
<tr>
<td>Impaired consciousness</td>
<td>5–10%</td>
<td>29%</td>
<td>Rare</td>
<td>Rare</td>
<td>Rare</td>
<td>&lt;1%</td>
<td>Frequent</td>
<td>30–50%</td>
<td>20–30%</td>
</tr>
<tr>
<td>Cognitive disorders</td>
<td>12–86%</td>
<td>40–50%</td>
<td>Rare</td>
<td>88%</td>
<td>10%</td>
<td>36%</td>
<td>Frequent</td>
<td>Frequent</td>
<td>?</td>
</tr>
<tr>
<td>Psychosis</td>
<td>4–6%</td>
<td>Rare</td>
<td>Rare</td>
<td>2%</td>
<td>Rare</td>
<td>Rare</td>
<td>Rare</td>
<td>Rare</td>
<td>Rare</td>
</tr>
<tr>
<td>Mood disorder</td>
<td>10–30%</td>
<td>Rare</td>
<td>Rare</td>
<td>Rare</td>
<td>Rare</td>
<td>Reactive</td>
<td>Rare</td>
<td>Rare</td>
<td>Rare</td>
</tr>
<tr>
<td>Visual deficits</td>
<td>5% (vasculitis, neuropathy, amaurosis fugax)</td>
<td>10–15%</td>
<td>Frequent (cranial neuropathy, ocular motor deficits)</td>
<td>1% (Optic neuropathy)</td>
<td>5–36% (Optic neuritis)</td>
<td>HSV</td>
<td>Frequent</td>
<td>Rare</td>
<td>Hemianopia</td>
</tr>
<tr>
<td>Sensory deficits</td>
<td>6–20%</td>
<td>15–20%</td>
<td>?</td>
<td>Up to 27%</td>
<td>5–10%</td>
<td>17%</td>
<td>Rare</td>
<td>Rare</td>
<td>30%</td>
</tr>
<tr>
<td>Cerebellar disorders</td>
<td>Rare (infarction)</td>
<td>Rare</td>
<td>Rare</td>
<td>Rare</td>
<td>Rare</td>
<td>Rare</td>
<td>Rare</td>
<td>Rare</td>
<td>Ataxia 10%</td>
</tr>
<tr>
<td>Cranial nerve involvement</td>
<td>5–35%</td>
<td>Frequent</td>
<td>Frequent</td>
<td>25%</td>
<td>5–72%</td>
<td>Cranial nerve palsy</td>
<td>Rare</td>
<td>Rare</td>
<td>10 (IV, III, VI, VII)</td>
</tr>
<tr>
<td>CRP</td>
<td>Normal</td>
<td>Normal</td>
<td>Frequently</td>
<td>Normal</td>
<td>Normal</td>
<td>normal ↑</td>
<td>↑</td>
<td>↑</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>1% (Transverse myelitis, 2–5% chorea)</td>
<td>30% Aphasias</td>
<td>Chronic meningitis, myelopathy</td>
<td>8% Meningo-encephalitis, 6% movement disorders</td>
<td>5–12% Meningitis, 10–28% myelitis, 10% hypothalamic and pituitary dysesthesia</td>
<td>Wernicke aphasia, dysphasia</td>
<td>Meninges, fever, ataxia</td>
<td>50% Fever, 25–30% meningitis</td>
<td></td>
</tr>
</tbody>
</table>

NPSLE, neuropsychiatric systemic lupus erythematosus; PML, progressive multifocal leukoencephalopathy; HSV, herpes simplex virus; ?, no data from clinical trials available.

Table 2  MRI findings in primary cerebral involvement of rheumatic diseases and opportunistic CNS infection

<table>
<thead>
<tr>
<th>MRI findings</th>
<th>NPSLE</th>
<th>Primary CNS vasculitis</th>
<th>Wegener’s granulomatosis</th>
<th>Neuro-Behçet</th>
<th>Neurosarcoidosis</th>
<th>PML</th>
<th>HSV encephalitis</th>
<th>Bacterial meningitis</th>
<th>Brain abscess</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>13–50%</td>
<td>0–50%</td>
<td>50%</td>
<td>30%</td>
<td>11%</td>
<td>Only in the early phase</td>
<td>Rare</td>
<td>?</td>
<td>Rare</td>
</tr>
<tr>
<td>Territorial infarction</td>
<td>15–30%</td>
<td>Frequently (e.g. middle cerebral artery)</td>
<td>15–20%</td>
<td>18%</td>
<td>Rare</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>In T2 hyperintense lesions of the cortex</td>
<td>0–9% Reversible</td>
<td>Rare</td>
<td>Cerebral granulomas (homogeneous, ring enhancement)</td>
<td>36–66% Meningo-encephalitis, 26% isolated brain stem or basal ganglia</td>
<td>30% Multiple or solitary supragranular and/or infratentorial, rarely brain stem or cerebellum</td>
<td>56% Thalamic, 32% posterior fossa</td>
<td>Haemorrhagic necrosis, temporal, insula, thalamus, hippoc., subfrontal</td>
<td>–</td>
<td>Frequent</td>
</tr>
<tr>
<td>White matter lesions (WML)</td>
<td>30–75% Subcortical &gt; deep white matter &gt; periventricular</td>
<td>Frequent infarcts often in the deep white matter</td>
<td>50% Periventricular, subcortical</td>
<td>16% Paraventricular, subcortical</td>
<td>40% Periventricular, subcortical, confluent</td>
<td>100% Subcortical, 93% para- and periventricular, 92% bilateral, 94% confluent, no mass effect</td>
<td>–</td>
<td>–</td>
<td>Frequent</td>
</tr>
<tr>
<td>Gd-DTPA enhancement of WML or cortical lesions</td>
<td>Only active lesions</td>
<td>Active lesions</td>
<td>Active lesions</td>
<td>Often but only active lesions</td>
<td>Often nodular or annular enhancement</td>
<td>&lt;10% Enhancement of the periphery</td>
<td>Often</td>
<td>–</td>
<td>Strong contrast enhancement</td>
</tr>
<tr>
<td>Atrophy</td>
<td>10–60%</td>
<td>Chronic stage</td>
<td>42%</td>
<td>20% Brain stem spinal cord lesions</td>
<td>38–57% Nodular or diffuse meningeal enhancement, 28% optic nerve enhancement</td>
<td>58% Infratentorial (e.g. brain stem), no perifocal oedema</td>
<td>Often brain oedema associated with the lesions</td>
<td>Meningeal enhancement, nodular lesions</td>
<td>Mass effect</td>
</tr>
</tbody>
</table>

Gd-DTPA, gadolinium-DTPA.
Table 3  Cerebrospinal fluid (CSF) findings in primary cerebral involvement of rheumatic diseases and opportunistic CNS infections

<table>
<thead>
<tr>
<th>CSF findings</th>
<th>Primary CNS vasculitis</th>
<th>Wegener's granulomatosis</th>
<th>Neuro-Behçet</th>
<th>Neurosarcoidosis</th>
<th>PML</th>
<th>HSV encephalitis</th>
<th>Bacterial meningitis</th>
<th>Brain abscess</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal findings</td>
<td>50%</td>
<td>10–90%</td>
<td>?</td>
<td>25–30%</td>
<td>19%</td>
<td>70%</td>
<td>Only in early stages</td>
<td>–</td>
</tr>
<tr>
<td>Pleocytosis</td>
<td>27–32%</td>
<td>20–50%</td>
<td>?</td>
<td>50–60%</td>
<td>?</td>
<td>20%</td>
<td>?</td>
<td>100%</td>
</tr>
<tr>
<td>Cell count</td>
<td>20–100</td>
<td>10–100</td>
<td>10–100</td>
<td>0–100 (mean 80)</td>
<td>5–200</td>
<td>19%</td>
<td>?</td>
<td>0–1000</td>
</tr>
<tr>
<td>Cell type</td>
<td>Lymphocytes</td>
<td>Lymphocytes</td>
<td>Lymphocytes</td>
<td>Lymphocytes</td>
<td>Lymphocytes</td>
<td>Lymphocytes</td>
<td>?</td>
<td>Orangulocytes</td>
</tr>
<tr>
<td>Raised protein content</td>
<td>30–48%</td>
<td>30%</td>
<td>50–1000</td>
<td>190–2300</td>
<td>500–1000</td>
<td>500–2000</td>
<td>&gt;1000</td>
<td>500–1000</td>
</tr>
<tr>
<td>IgG index &gt;0.6</td>
<td>30%</td>
<td>50–100</td>
<td>500–1000</td>
<td>500–1000</td>
<td>500–1000</td>
<td>500–1000</td>
<td>&gt;1000</td>
<td>500–1000</td>
</tr>
<tr>
<td>Oligoclonal bands</td>
<td>25–42%</td>
<td>25–42%</td>
<td>25–42%</td>
<td>25–42%</td>
<td>25–42%</td>
<td>25–42%</td>
<td>&gt;1000</td>
<td>&gt;1000</td>
</tr>
</tbody>
</table>

ACE, angiotensin converting enzyme; CSF, cerebrospinal fluid; IgG index, CSF IgG/serum IgG (normal value <0.6); protein content (normal value 180–430 mg/l); JCV, JC virus. 

Among healthy volunteers, 65–90% have antibodies against, and are carriers of, the JC virus. One study demonstrated a correlation between the immune system and the occurrence of PML, which is associated with high counts of circulating CD4+ T cells and the presence of the JC virus in the brain. In our case, the patient's CD4+ T cell count was 0.2, which is within the normal range. This suggests that a low CD4+ T cell count may not be a sufficient condition for the occurrence of PML. Other factors, such as the presence of the JC virus in the brain, may also play a role in the development of PML. 

In conclusion, the occurrence of PML is not only dependent on the immune system, but also on other factors such as the presence of the JC virus and the number of immune cells. Further studies are needed to better understand the role of these factors in the development of PML.
is interpreted as an indicator of an immune response to viral antigens in long term survivors. Despite a rather characteristic presentation of advanced PML in MRI analysis the differential diagnosis remains a challenge, because cases of central nervous system SLE mimicking PML have been reported. Therefore, the next step in confirming a suspected diagnosis of PML must be analysis of the CSF for the presence of JC virus DNA by PCR. This test reaches a sensitivity of 93% and a specificity of 99% while PCR analysis performed in urine or blood samples was not specific for PML. Whether the viral load correlates with the prognosis is still being debated. The firm diagnosis—unfortunately often post mortem—is made by histological examination, showing enlarged oligodendrocytes with an expanded cytoplasmic compartment and intranuclear inclusions (“ground glass”), which represent the polyoma viruses. Therefore, stereotactic brain biopsy is strongly recommended in all cases of suspected PML and negative JC virus PCR in CSF samples.

The primary differential diagnoses include other viral infections (HIV, HSV, CMV), toxoplasmosis, neuropsychiatric SLE (in patients with known SLE), lymphoma, toxic encephalitis after chemotherapy, vasculitis, and neurosarcoidosis (tables 2 and 3). Interestingly, the vascular lesions shown by cerebral angiography in patient No 3 strongly argue against PML as the cause of the primary symptoms in this patient. On the other hand, it has to be kept in mind, that several infectious agents have to be ruled out in the assessment of patients with possible cerebral vasculitis, because a variety of pathogens have a propensity to affect blood vessels—for example, aspergillus, candidiasis, cisticercosis, coccidioidomycosis, Strongyloides stercoralis, arbovirus, VZV, and hepatitis C virus infection.

The prognosis for PML is usually poor. No effective treatment is available at present; anecdotal reports show some efficacy ofcidofovir, interferon alfa, and cytosine arabinoside. Nevertheless, PML may remit if the underlying immunodeficiency improves, therefore discontinuation of immunosuppressive agents should receive a high priority. MRI findings of early white matter lesions caused by JC virus are non-specific and may be indistinguishable from early brain abscesses. However, contrast enhancement or mass effects of the lesions visualised by MRI helps to distinguish cerebral abscesses from PML and HSV encephalitis. Differential diagnosis includes primary brain tumours, metastasis, or cerebrovascular events.

Symptoms in patients with brain abscess are headache, fever, focal neurological deficits, confusion, meningitis and seizures, all of which may also occur in patients with cerebral metastasis or CNS involvement due to ANA or ANCA positive vasculitis. However, fever and meningitis are rarely seen in systemic rheumatic diseases, with the exception of WG. If a spinal tap is contraindicated owing to the mass effect of the brain abscess, the preferred diagnostic procedures are stereotactic brain biopsy followed by histological and microbiological analysis.

Typical microbes which can cause brain abscess formation are Toxoplasma gondii, fungi (aspergillus, candida, or cryptococci), mycobacteriosis, Listeria monocytogenes, and Nocardia asteroides. Thirty two cases of SLE associated nocardiosis have been reported. Lungs, skin, and brain were the organs most commonly affected. Nocardiosis of the CNS was found in up to 30% of these patients and was associated with a high mortality. Nocardia should be kept in mind as a possible pathogen in patients whose infections do not respond to third
generation cephalexins. Preferred antibiotics are trimethoprim-sulfamethoxazole and imipenem.

When revising the current literature to assess whether there exist specific signs to differentiate between CNS involvement of systemic rheumatic diseases and CNS infection. As shown in tables 1–3, the clinical distinction is always vague and remains difficult in certain patients because of overlapping clinical features. Differential diagnosis includes toxic leukoencephalopathy caused by therapeutic agents (for example, cyclosporin, tacrolimus, amphotericin B, antineoplastic therapeutic drugs), hypertensive encephalopathy, and metabolic complication involving the nervous system, such as hydrolecrotyclic changes.

Finally, what are the lessons taught from our three cases? Firstly, in patients who are strongly immunosuppressed, the new onset or change of cerebral symptoms should alert the doctor to look carefully for opportunistic infections. Blood cultures and brain imaging (MRI) should be the first step of the clinical evaluation (fig 4). If CNS infection, especially bacterial meningitis or abscess formation, cannot be ruled out, empirical treatment should be started following the guidelines for immunosuppressed patients. In patients with mass effect of brain lesions, stereotactic brain biopsy should be started without delay, otherwise spinal tap and CSF analysis including PCR to detect JC virus, HSV, VZV, EBV, and CMV should be performed. The diagnosis of nervous system infection may also be confirmed by the presence of antibodies to HSV, VZV, EBV or CMV in the CSF even without detectable DNA.

Secondly, in cases where the diagnosis is not clear we suggest that immunosuppression should not be intensified until an opportunistic infection has clearly been ruled out. An alternative strategy in this setting would be the treatment with intravenous immunoglobulins (IV IgG) combined with antibiotics, especially in patients who have hypogammaglobulinaemia. In several autoimmune diseases—for example, SLE and ANCA positive vasculitis, uncontrolled studies have suggested that IV IgG may be an effective therapeutic option. IV IgG treatment has also been shown to decrease the frequency and severity of exacerbations in multiple sclerosis. Polyclonal immunoglobulins have complex immunoregulatory effects, including the neutralisation of microbial toxins, and contain a broad range of antibodies against pathogens. Because the efficacy of IV IgG is not documented in CNS manifestations of systemic rheumatic diseases, this treatment strategy should be restricted to patients with hypogammaglobulinaemia until controlled trials demonstrate a clear benefit.

Because CNS infection carries a high mortality rate and full recovery can be expected only in a small percentage of patients, multicentre studies are warranted to answer the following questions: (a) Which factors define patients at risk for opportunistic CNS infections in systemic rheumatic diseases? (b) Which imaging procedure may help to detect and distinguish CNS infection in these patients?

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Infectious CNS disease in systemic rheumatic diseases


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