Liver abnormalities and liver membrane autoantibodies in systemic lupus erythematosus

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SUMMARY The hepatic involvement of 57 patients with systemic lupus erythematosus (SLE) was studied with special reference to liver membrane autoantibody (LMA). Liver abnormalities were found predominantly in patients with active SLE (27/48 (56%) in active SLE v 3/20 (15%) in inactive SLE). They were, however, rather mild or moderate and tended to disappear as the disease activity of SLE decreased. In this respect the liver abnormalities observed in this study differed from those in patients with lupoid hepatitis. The incidence of LMA in active SLE (8/11 (73%)) was significantly greater than that in inactive SLE (4/12 (33%)). The mean LMA index value in active SLE was 8-3, which was also greater than the 2-9 in inactive SLE. Furthermore, in active SLE the mean LMA titre was significantly higher in patients with liver abnormalities than in those without. These results suggest that LMA may be associated with the activity of SLE and may be one of the factors which cause transient liver abnormalities.

It is well known that systemic lupus erythematosus (SLE) often presents various clinical features owing to multiple organ involvement. For example, lesions in the kidney, lung, or central nervous system have been widely investigated and commonly called lupus nephritis, lupus pneumonitis, and central nervous system lupus respectively.\(^1\) On the other hand, clinical or aetiological aspects of hepatic involvement have not been seriously studied,\(^1^-^3\) though a relatively high incidence of some liver abnormalities has been observed—20-70% in cases of SLE.\(^3^-^8\)

Liver membrane autoantibody (LMA) was first detected in man by Hopf et al.\(^9\) in 1976 and has been found predominantly in patients with autoimmune chronic active hepatitis\(^10^-^12\) or lupoid hepatitis.\(^13\) To our knowledge, however, little is known about the role of LMA in the liver abnormalities occurring in patients suffering from SLE.

In this study we investigated the incidence and clinical features of liver abnormalities and the significance of LMA in association with SLE.

Patients and methods

Patients
Fifty seven patients with SLE, one male and five females, ranging in age from 15 to 64 years (range 15-64). The patients were divided into four groups based on their state—that is, with or without SLE activity and with or without liver disease. From these 57 patients, 68 samples (three different serum samples from one patient and two from nine patients) were examined.

The disease activity of SLE
SLE activity was assessed according to a statistically validated lupus activity criteria count.\(^8\) The presence of any two or more of the following nine features or groups of features constitutes active SLE: (a) arthritis; (b) laboratory abnormalities, namely positive LE cell preparation or white cell count <4×10\(^9\)/l or decreased CH\(_50\) or C\(_3\), or presence of DNA antibodies; (c) rash or mucous membrane ulcers or alopecia; (d) pleuritis or pericarditis; (e) seizures, etc.
psychosis, organic brain syndrome, or headache due to SLE; (f) vasculitis; (g) haematuria.

With these criteria the SLE activity was classified as active or inactive.

**Assessment of Liver Abnormalities**

As the liver abnormalities in most patients were rather short term and transient, evaluations of liver abnormalities were made by four serum enzymes: serum aspartate transaminase (AST), serum alanine transaminase (ALT), serum alkaline phosphatase, and lactic dehydrogenase. When two or more enzymes, including at least one of the transaminases, were increased liver abnormalities were considered to be present. Other causes of increased enzyme activities, especially heart or muscle disease, were excluded. Previous experience was used to define serum enzyme increases as follows: serum AST >45 IU/l (normal range 0–40), serum ALT >40 IU/l (0–35), serum alkaline phosphatase >120 IU/l (30–110), and lactic dehydrogenase >280 IU/l (120–250).

**Assay of Liver Membrane Autoantibody**

Liver membrane autoantibody titres were assayed in 38 serum samples obtained from 33 patients with SLE. In addition to the normal controls, four patients with hepatitis B surface antigen (HBsAg) positive chronic active hepatitis, which had been histologically diagnosed, were also examined.

LMA titres were measured using rat liver cell coating plates, according to the radioimmunoassay techniques of Kronborg et al. Fresh rat liver cell coating plates (2×10⁵ cells/well) were fixed with 3% paraformaldehyde solution. Serum samples (50 μl) were added to each well with 500 μl of TRIS buffered saline (50 mM TRIS; 2% bovine serum albumin; 20 mM EDTA-2Na; 0.05% Tween; 10% sheep serum; 0.05% NaN₃; pH 7.5), and the plates were incubated for 16 hours at 25°C on the shaker. The plates were washed three times with 0.05% Tween-saline, then 500 μl of ¹²⁵I labelled protein A in phosphate buffered saline (PBS) (10⁵ cpm) was added to each well, followed by one hour’s incubation at 25°C on the shaker. The plates were then washed three times with 0.05% Tween-saline, 500 μl of 0.5 M acetic acid was added to each well, and free ¹²⁵I labelled protein A was removed. Finally, each well was counted for radioactivity. The LMA titre was expressed as an index value (IV), which was defined by the formula: (sample counts – normal control counts)/100x(normal control counts), and the LMA was judged as + (IV≥2.0), ± (2.0>IV≥1.0), or − (IV<1.0). Fourteen serum samples from healthy persons were used as controls.

**Liver Membrane Autoantibody Detection by Immunofluorescence**

Fresh rat liver cells were cultured on cover glasses in wells (2×10³ cells/well) for two days at 37°C. The cover glasses were washed with PBS, fixed with acetone for 10 minutes, and then dried. Serum samples, diluted 1:10 with PBS, were then placed on the cover glasses and incubated in a 100% moisturised plastic box for one hour at 37°C. The cover glasses were washed with PBS, dried, and then filled with 1:5 diluted fluorescein isothiocyanate conjugated goat antihuman immunoglobulin (MBL, Nagoya, Japan). They were then incubated in a 100% moisturised plastic box for one hour at 37°C. Thereafter, they were washed with PBS and mounted with 50% glycerin-PBS for observation by a fluorescence microscope. For immunofluorescence in living hepatocytes, suspended cells (1×10⁶) were incubated with 100 μl serum diluted 1:10 at 4°C. After 30 minutes of incubation the cells were washed three times with PBS, then incubated with 50 μl of 1:50 dilution of fluorescein isothiocyanate conjugated goat antihuman immunoglobulin at 4°C for 30 minutes, and washed three times with PBS. The final cell pellets were suspended in 20 μl of 50% glycerin-PBS, mounted on slide glasses, and examined by fluorescence microscopy.

**Statistical Analysis**

A χ² test was used to assess the differences in the incidence of liver dysfunction and that of LMA. Student’s t test was used to assess the differences in mean LMA titre among the groups. Results are expressed as means (SD).

**Results**

**Incidence of Liver Abnormalities**

Sixty eight serum samples from 57 patients with SLE were evaluated for liver functions. Liver abnormalities were seen in 29 of 48 (60%) samples from patients with active SLE and in six of 20 (30%) inactive SLE samples. Two patients in the former group and one in the latter were found to have fatty liver and two patients in the latter were diagnosed as having drug induced hepatitis. When these samples were excluded the incidence of liver abnormalities probably due to SLE was 27 of 48 (56%) in the group with active SLE and three of 20 (15%) in the inactive SLE group. These results suggested that liver abnormalities were found predominantly in patients with active SLE (p<0.005). In most of our patients liver abnormalities developed at the onset or during the exacerbation of SLE. Furthermore, none of the patients took non-steroidal anti-
inflammatory drugs, including aspirin. We gave immunosuppressive drugs to some patients, two of whom developed obvious drug induced liver dysfunctions as mentioned above. We used no other drugs that were supposed to induce liver abnormalities. Hence these liver abnormalities were considered to be associated with the SLE itself and not with drugs.

**Liver Enzyme Value in Active SLE with Liver Abnormalities**

Of the 27 patients with liver abnormalities and active SLE, increases of serum AST, serum ALT, lactate dehydrogenase, and serum alkaline phosphatase were generally mild or moderate (mean (SD): serum AST 278 (314) IU/l, serum ALT 201 (189) IU/l, lactate dehydrogenase 428 (159) IU/l, serum alkaline phosphatase 165 (173) IU/l). Only five serum samples presented with serum AST>500 IU/l, and only one serum sample showed serum AST>1000 IU/l. The number of cases with serum AST>500 IU/l was only two. In 24 of the 27 cases (89%) increases of transaminases were transient and decreased in parallel with the inactivation of SLE by treatment. Figure 1 shows the changes in serum AST and serum ALT values as the SLE changes from active to inactive. No patient had jaundice or hyperbilirubinaemia.

**Liver Membrane Autoantibody Titres**

Thirty eight serum samples from 33 patients with SLE were assayed for LMA (Table 1 and Fig. 2). We found LMA in 21/25 (84%) samples from active SLE and in only 5/13 (38%) from patients with inactive SLE (p<0.005). In active SLE samples LMA was found in 13/14 (93%) of those with liver abnormalities and in 8/11 (73%) of those without abnormalities, but the difference was not statistically significant. On the other hand, the incidence of LMA in inactive SLE without liver abnormalities was 4/12 (33%), significantly lower than that in active SLE samples (p<0.05). In addition, as shown

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Table 1 Incidence of liver membrane autoantibody in patients with or without disease activity of systemic lupus erythematosus and liver abnormalities

<table>
<thead>
<tr>
<th>State of SLE†</th>
<th>No (%) of LMA‡ positive samples</th>
<th>Total No (%)</th>
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<tbody>
<tr>
<td></td>
<td>With liver abnormalities</td>
<td>Without liver abnormalities</td>
</tr>
<tr>
<td>Active (n=25)</td>
<td>13/14 (93)</td>
<td>8/11 (73)*</td>
</tr>
<tr>
<td>Inactive (n=13)</td>
<td>1/1 (100)</td>
<td>4/12 (33)</td>
</tr>
</tbody>
</table>

*p<0.05 compared with inactive SLE without liver abnormalities; **p<0.005 compared with inactive SLE.

†SLE=systemic lupus erythematosus; LMA=liver membrane autoantibody.
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active hepatitis all showed a negative test for LMA (data not shown).

Figure 3 shows that the LMA titre is inversely correlated with the CH50 value, which is one of the indices of disease activity. This result may support the above mentioned relation between LMA and disease activity of SLE. Moreover, in five patients whose SLE was initially active LMA titre fell as the disease activity of SLE decreased during a period of two to 12 months (Fig. 4). These results indicate that LMA may be associated with the disease activity of SLE and, if not entirely, then partly, with the liver abnormalities in SLE.

RELATION BETWEEN LIVER MEMBRANE AUTOANTIBODY AND ANTINUCLEAR ANTIBODIES

As antinuclear antibodies are found in the serum samples of most patients with SLE there was a

in Fig. 2a, the mean LMA index value in active SLE samples was significantly higher than that in inactive SLE (p<0.05). It was also found that among patients with active SLE the LMA index value was significantly higher in patients with liver abnormalities than in those without (p<0.05) (Fig. 2b). The four patients with HBsAg positive chronic

Fig. 3 Relation between liver membrane autoantibody (LMA) index and CH50 values.

RELATION BETWEEN LIVER MEMBRANE AUTOANTIBODY AND ANTINUCLEAR ANTIBODIES

in Fig. 4, the changes of liver membrane autoantibody (LMA) index values as the systemic lupus erythematosus (SLE) changes from active to inactive during a period of two to 12 months.

Fig. 5 Fixed rat hepatocytes stained by indirect immunofluorescence with liver membrane autoantibody (LMA) positive or negative serum. (a) Bright staining of the surface and cytoplasm in addition to the nuclei when the LMA positive systemic lupus erythematosus (SLE) serum was used. (b) Staining of the nuclei only, with dark surface and cytoplasm, when the LMA negative SLE serum was used.
Discussion

In this study we investigated the hepatic involvement in SLE and the association of LMA with the disease activity of SLE and liver abnormalities. Rothfield reported raised liver enzyme activities in about 30% of patients with SLE at the time of diagnosis when active disease was evident and found that they returned to normal with corticosteroid treatment. Morito et al also observed a coincidental transaminase increase in 11/23 patients during an exacerbation of SLE. In our study liver abnormalities not due to drugs, but probably due to SLE, were found in 27/48 (56%) patients with active SLE and in only 3/20 (15%) of those with inactive SLE, which is compatible with previous reports. The increase of serum transaminase concentration was mild or moderate, and no patient had jaundice or an increase of total bilirubin. Dubois and Tuffanel found jaundice in 3-8% of 520 patients with SLE, and Kofman et al observed hyperbilirubinaemia in 27% and jaundice in 12% of 25 patients with SLE.

In patients with SLE histologically non-specific and mild liver changes are common, but severe damage is rare. Benner et al, analysing 37 cases of SLE with hepatic involvement in 12 publications, concluded that the liver damage was not severe and would never be the cause of death. On the other hand, in several papers severe liver damage in SLE has been reported. There seems to be no clear criteria for distinguishing hepatic involvement in SLE from autoimmune hepatitis. Although we did not examine our patients histologically, we found no clinical evidence of chronic active hepatitis. Thus, there seems to be a type of liver abnormality in patients with SLE which is clinically distinct from lupoid or autoimmune hepatitis because of its transiency, mild or moderate transaminase increase, or absence of an increase in total bilirubin. Liver abnormalities of this type in SLE may be identical to 'hepatic lupus', first named by Mackay et al, which means a mild liver dysfunction found in SLE which is clinically and histologically different from lupoid hepatits.

Autoantibodies to liver membranes are commonly classified into two types. One is the antibody to liver specific membrane lipoprotein and the other is LMA. Some studies have shown that these antibodies are each directed against different antigens of liver membranes. Although antibodies to liver specific membrane lipoprotein have been detected in both acute and chronic hepatitis independently of HBsAg, LMA has been found predominantly in patients with autoimmune chronic active hepatitis. So far, 40-70% of patients with autoimmune chronic active hepatitis have been reported to be positive for LMA. Frazier et al reported that LMA titres correlated with the activity of autoimmune chronic active hepatitis. The pathogenetic significance of these autoantibodies is still unsettled, but some investigators consider them antibody dependent, cell mediated cytotoxic reaction is a major effector mechanism. It seems, however, that not very much attention has been paid to LMA in association with SLE or hepatic involvement of SLE. In the limited number of publications available the incidence of LMA in patients with SLE has been reported to be lower. Frazier et al found no difference in LMA titres of 14 patients with SLE and normal individuals, and Wiedmann et al rarely observed LMA in patients.
with SLE.\textsuperscript{12} They scarcely discussed the role of LMA in SLE. In contrast, we showed a high incidence of LMA in patients with active SLE, and also showed that LMA titres fell in parallel with the decrease of SLE activity in five patients. It was also found that LMA titres correlated inversely with CH\textsubscript{50}. These results suggest that LMA may be associated with the disease activity of SLE. Moreover, the titres of LMA were significantly higher in patients with SLE with liver abnormalities than in those without them, indicating that LMA may be involved in the liver damage observed in SLE. LMA was negative in all four patients with HBsAg positive chronic active hepatitis. This is compatible with other reports, which showed a tendency for LMA to be less commonly detected in patients with HBsAg positive chronic active hepatitis than in those with autoimmune chronic active hepatitis.\textsuperscript{12 13 30} For example, Toda \textit{et al.} reported that LMA was detected more often in patients with HBsAg negative liver cirrhosis than in those with the HBsAg positive form (six of 13 v two of 11).\textsuperscript{30}

When the serum samples of LMA positive patients with SLE were used fluorescence staining was observed more brightly on the surface and cytoplasm of fixed rat hepatocytes and the surface of living rat hepatocytes than in the nucleus. This staining pattern confirmed the results obtained by radioimmunoassay, which indicated that LMA is against the antigen of the membrane rather than against the nucleus of hepatocytes. These facts exclude the possibility that LMA obtained by radioimmunoassay may reflect antinuclear antibodies, which most patients with SLE possess.

In general, various autoantibodies, such as antinuclear antibody, rheumatoid factor, or platelet associated IgG, appear in association with hypergammaglobulinaemia in active SLE. LMA may also be one of them. As there was statistical significance between the LMA titres of patients with and without liver abnormalities, however, we suggest that LMA is an autoantibody which appears during the active phase of SLE and which participates, if not entirely, then partly, in the autoimmune pathogenesis of the hepatic involvement in SLE. The results obtained here also indicate that the liver abnormalities due to SLE may share the same cause as lupoid or autoimmune hepatitis, though their clinical features are clearly distinct. Further studies are needed to clarify the clinical significance and the basal mechanism of LMA.

\textbf{References}