Lysozyme in chronic liver disease: a biochemical and histological study

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SUMMARY Serum lysozyme activities and semiquantitative analysis of tissue lysozyme distribution were studied in patients with primary biliary cirrhosis (PBC), chronic hepatitis (CH), miscellaneous liver diseases, and normal subjects. Serum lysozyme was significantly raised in PBC and CH. Portal venous blood has similar lysozyme activities to peripheral venous blood in a group of various liver diseases. Lysozyme-containing intralobular cells were decreased in all liver diseases studied but portal tract lysozyme was increased only in PBC and CH. Thus the increase in serum lysozyme in PBC and CH appears to originate from the portal inflammatory infiltrate, seen in these diseases.

There have been several studies of serum lysozyme as a possible marker of chronic inflammatory activity. Raised activity has been reported in sarcoidosis, correlating with extent and activity of the disease,[1] and in tuberculosis.[2][3] Many investigations of serum lysozyme have been carried out in inflammatory bowel disease[4-8] but results are conflicting. The rationale for these studies is that lysozyme is found in granulocytes, monocytes, and macrophages and is more abundant in cells involved in active inflammation than in normal tissue.[9][10]

Lysozyme is also found in Küpffer cells.[9] There have been relatively few studies of serum lysozyme in hepatic disease. Raised activities have been reported in acute and chronic hepatitis,[11] but results in cirrhosis have been conflicting.[11-13] We have therefore studied serum activities and intrahepatic tissue distribution of lysozyme in various liver diseases and controls.[14] Simultaneous portal and peripheral venous samples were also obtained from a small group of patients with various liver diseases to assess the possible contribution to serum activity of gastrointestinal tract and splenic lysozyme.

Material and methods

SERUM LYSOZYME
Serum lysozyme was measured turbidimetrically by the rate of lysis of *Micrococcus lysodeikticus*[15] (Worthington Diagnostics). The absorbance change from 30 to 60s[16] after enzyme addition was meas-

ured on a Unicam SP1800 spectrometer. Sera were measured in batches, each batch separately standardised with egg albumen lysozyme and incorporating quality control. Specimens were stored at −20°C and assayed within one month. Patients with raised serum creatinine were excluded from the study. Serum alanine transaminase (ALT), aspartate transaminase (AST) and alkaline phosphatase (AP) were measured by autoanalyser and differential white cell counts performed.

DEMONSTRATION OF TISSUE LYSOZYME
A modified indirect immunoperoxidase technique[17] was used on paraffin sections (4μm) of formalin-fixed liver biopsies. Sections were initially treated with rabbit antihuman lysozyme, washed, and exposed to peroxidase-conjugated goat antirabbit IgG (Dako Immunoglobulins Ltd). Subsequent treatment with diaminobenzidine (BDH) and hydrogen peroxide formed the brown final reaction product. Appropriate controls were included; non-immune sera and diaminobenzidine alone were used to assess non-specific binding and endogenous peroxidase (non-immune goat serum, Sera Lab Ltd, non-immune rabbit serum, Gibco Bio-Cult Diagnostics Ltd). Sections were stained in batches with controls known to be positive for lysozyme. Haematoxylin was used as a counterstain.

Coded sections were analysed by the same observer throughout. The mean number of lysozyme positive intralobular cells per microscope field was determined. The amount of lysozyme in portal tracts was assessed semiquantitatively on a five point scale.

The scores from the first five tracts analysed for each biopsy, were added (the number of portal tracts per biopsy varied widely) thus deriving a single independent variable per biopsy.

SUBJECTS

Serum lysozyme
All cases of liver disease were biopsy proven. Thirty-two patients with primary biliary cirrhosis (PBC), 14 with chronic active and chronic persistent hepatitis (CH), and 15 with miscellaneous liver diseases (hepatoma, hepatic fibrosis, extrahepatic cholestasis, alcoholic liver disease, granuloma, schistosomiasis and halothane hepatitis) were studied. Forty-seven control subjects were drawn from hospital staff, out-patients with minor complaints and the local population. Hepatic or other inflammatory disease was excluded as far as possible from the control group. Simultaneous portal and peripheral blood samples were obtained either at laparotomy for portacaval shunting or during the course of percutaneous transhepatic cholangiography when portal vessels were incidentally entered. This group included the following diseases: PBC, CH, extrahepatic obstruction, cholangiocarcinoma, acute hepatitis, and cryptogenic cirrhosis.

Tissue lysozyme
The following cases were studied: 20 with PBC, 20 with CH, 40 with miscellaneous liver diseases including alcoholic liver disease, primary and secondary malignancy, granuloma, extrahepatic cholestasis, acute hepatitis, haemosiderosis and cryptogenic cirrhosis. A control group of 20 biopsies showing normal histology on conventional staining was also studied.
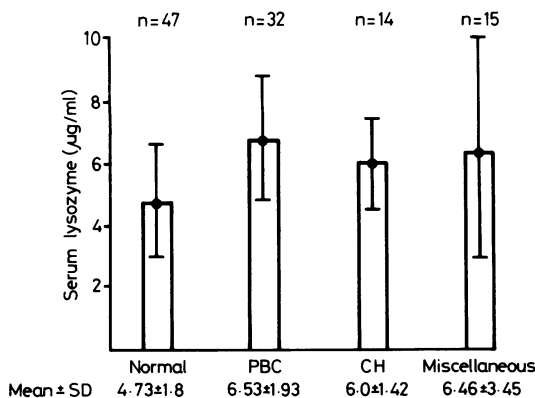
STATISTICAL METHODS

Comparisons of serum lysozyme between groups and numbers of lobular lysozyme positive cells between groups were made using Student's t test with Welch's approximation for inequality of variance where appropriate.[18] Correlation coefficients were calculated to test for significant linear relations between serum lysozyme activities and creatinine, ALT, AST, AP and peripheral blood leucocyte counts. Portal and peripheral lysozyme activities within the same patient were compared using the paired t test and, because of small numbers, the non-parametric, Wilcoxon paired rank summation test and the sign test, were also used. Since the data on portal tract lysozyme was semiquantitative, it was analysed using a contingency table in which the members of each group were classified into a high score or low score category. Significance was assessed by means of the χ^2 test. A small number of cases had to be excluded because too few (or no) portal tracts were analysable.
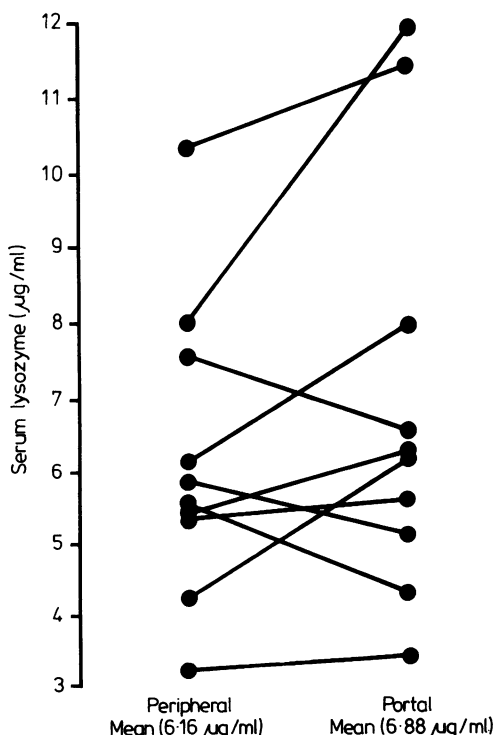

Fig. 2 *Simultaneous portal venous and peripheral venous blood lysozyme activities in a group of miscellaneous liver disease patients.*

Fig. 1 *Serum lysozyme activities in normal and disease groups.*

Results

Serum lysozyme activities were significantly raised in PBC (p < 0·001) and CH (p < 0·01) but there was no significant difference between these two groups. The miscellaneous liver disease group was not significantly different from normals but the variation in the group was very large (Fig. 1). Serum lysozyme correlated with peripheral blood monocyte counts in PBC (r = 0·44, p < 0·05, n = 23 patients) and with peripheral blood granulocytes in normals (r = 0·43, p < 0·05, n = 23 subjects). Serum creatinine concentrations were not significantly different between patients and controls and did not correlate with serum lysozyme activities. Serum AST, ALT, and AP activities did not correlate with serum lysozyme activities in patients. Portal venous lysozyme did not differ significantly from peripheral venous activity by any of the tests used (Fig. 2).

Lysozyme was seen in biopsies in intralobular sinusoidal-lining cells and in some portal tract cells. There were significantly fewer lysozyme-positive
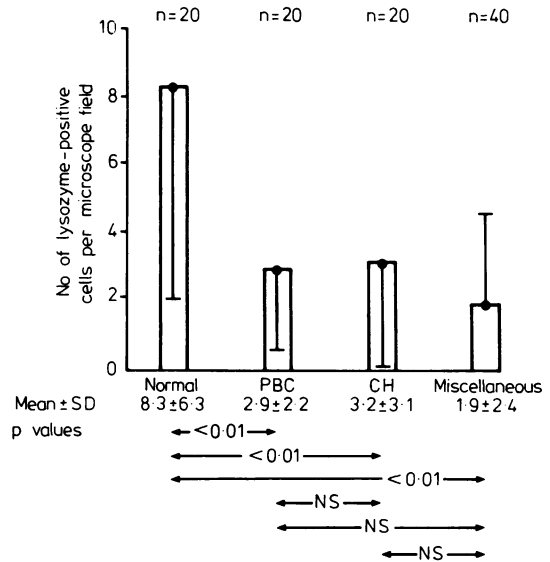

Fig. 3 *Intralobular lysozyme. Number of lysozyme-positive cells per microscope field, in normal and disease groups.*
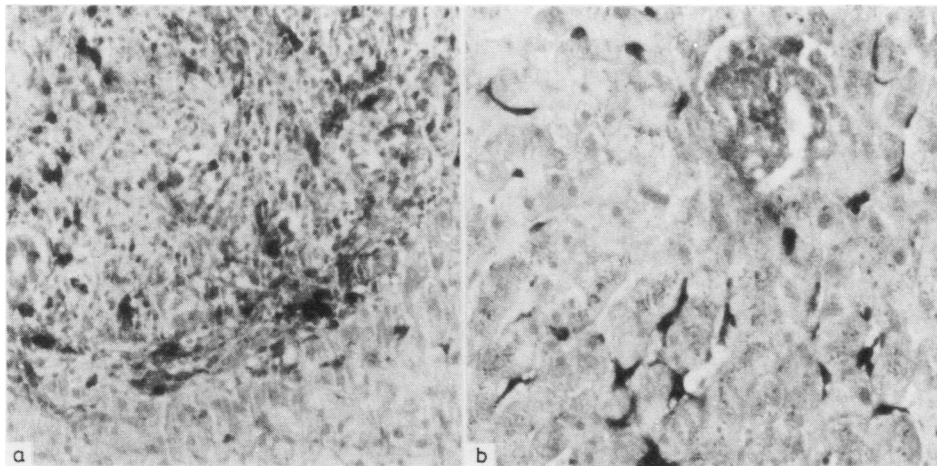

Fig. 4 *Immunohistochemical demonstration of lysozyme distribution in (a) primary biliary cirrhosis and (b) normal liver. Note the abundance of lysozme-containing cells in the portal tract in primary biliary cirrhosis and the relative paucity of positive sinusoid-lining cells in the adjacent lobule. Indirect immunoperoxidase/haematoxylin × 558.*

Table 1 *Portal tract lysozyme. Normal and disease group patients classified into high or low portal tract lysozyme scores*

Group	Score	
	Low (0–2)	High (≥3)
PBC	3	16
CH	5	10
Miscellaneous	23	8
Normal	14	5

Table 2 *Portal tract lysozyme significance levels*

	PBC	CH	Miscellaneous	Normals
PBC	—	—	—	—
CH	NS	—	—	—
Miscellaneous	< 0·001	< 0·025	—	—
Normals	< 0·005	< 0·05	NS	—

NS = not significant.

intralobular cells in disease groups than normals but no significant difference between groups (Fig. 3). On examining portal tracts there was significantly more lysozyme in both PBC and CH than in either normals or the miscellaneous disease group (Fig. 4). There was no difference between PBC and CH and no difference between normals and the miscellaneous group (Tables 1 and 2).

Discussion

We have demonstrated that serum lysozyme is raised in PBC and CH and that peripheral and portal blood activities do not differ significantly in the group studied. There was a depletion of hepatic lobular lysozyme-positive cells in liver disease and an increase in lysozyme-positive portal cells in PBC and CH.

The very wide variation in serum activity in the miscellaneous group suggests that larger samples of the separate diseases in this group should be studied. There was too much overlap in serum lysozyme between PBC and CH and between these conditions and normals for the measurement to be of diagnostic value. The spleen and gastrointestinal tract are possible sources of lysozyme contributing to serum activity; Paneth cells of the small intestine contain granules rich in lysozyme[19] and we have noted lysozyme activities in splenic homogenates considerably higher than in serum. However, in the group of various liver diseases studied here the overall lack of significantly higher values in portal blood suggests that the gastrointestinal tract and spleen do not make the major contribution to serum lysozyme activity.

The histological findings suggest two possible mechanisms for the raised serum lysozyme activities in PBC and CH. Firstly, the lack of positive intralobular sinusoidal-lining cells (presumed Küpffer cells) indicates a possible total discharge of lysozyme from many of them into the circulation. This would be analogous to the mechanism suggested for coeliac disease[20] of total enzyme discharge from Paneth cell granules into the blood to explain the observed decrease in small intestinal tissue lysozyme and increase in serum lysozyme[21] which is seen in this condition.

Secondly, the enzyme could be released primarily by the lysozyme-positive elements of the portal tract infiltrate, which are seen in increased numbers only in PBC and CH in our study. This second hypothesis seems more attractive since:
(a)   the portal tracts are the obvious centres of origin of inflammatory activity in these diseases.
(b)   we observed more lysozyme in tracts which had damaged architecture than in those architectur-

ally normal, although this observation would not be amenable to quantification.
(c)   macrophages in culture are seen to synthesise and secrete large amounts of lysozyme rather than to discharge it totally.[22]
(d)   raised serum lysozyme activities are seen in viral hepatitis,[11] a condition associated initially with Küpffer cell proliferation rather than depletion.

Lysozyme has been found in granulocytes and it has been suggested[23] that the serum activities in normal individuals largely reflect the rate of physiological granulocyte turnover. It has also been suggested[5] that any severe infection will increase lysozyme release because of leucocyte destruction. Our findings of a correlation between serum lysozyme and peripheral granulocyte counts in normal individuals is in accord with a granulocyte origin of serum lysozyme in this group. However the cellular inflammatory infiltrate in the liver in PBC and CH is almost completely composed of mononuclear cells such that granulocyte lysozyme would seem to be of little importance in the excessive production of the enzyme in these diseases. The pathological significance of the correlation between peripheral blood monocyte counts and serum lysozyme in PBC is offset by the fact that the mean monocyte count was lower in PBC than in controls ($0.26 \times 10^9/l$ v $0.46 \times 10^9/l$), whereas the mean serum lysozyme was higher in PBC than in controls. This suggests that lysozyme secreted by circulating monocytes is not the cause of the observed difference in serum activities. Also the similarity between mean creatinine concentrations in normals and patients and the lack of correlation with serum lysozyme suggests that the raised lysozyme activities are not due to any impairment of renal excretion in liver disease.

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