

Relationship Between the Diagnosis, Preoperative Evaluation, and Prognosis After Orthotopic Liver Transplantation

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The purpose of this study was to identify which of the biochemical, immunological, or functional parameters derived before surgery as part of a systemic evaluation were helpful in predicting the frequency of rejection episodes, the chance of survival, and the cause risk of death (should death occur) of patients after orthotopic liver transplantation (OLTx). Ninety-eight adult patients who had an extensive preoperative protocol evaluation were studied before OLTx. The biochemical parameters assessed were albumin, prothrombin time, bilirubin, and ICG clearance. The immunologic parameters assessed included total lymphocytes, T3 cells, T4 cells, T8 cells, and the T4/T8 ratio. The degree of histocompatibility antigen (HLA) matching between the donor and the recipient was also evaluated in 80 of the 98 patients studied.

Most postoperative deaths occurred within 12 weeks of the procedure (24%; 24 of 98 patients); 13 patients (13%) died within the first 6 postoperative weeks, of either bacterial or fungal sepsis. An additional 14 patients (14%) died after the initial 6 postoperative weeks due, primarily of an acquired viral and/or protozoan infection ($p < 0.01$).

During the first 6 weeks, survival was better for patients with cholestatic liver disease (ChLD, 93%, $n = 45$) and miscellaneous liver diseases (MISC, 100%, $n = 10$) than it was for those with parenchymal liver diseases (PLD, 77%, $n = 43$).

Although albumin, prothrombin time, T4/T8 ratios, and per cent T8 cells were statistically different in patients with PLD as compared with those with ChLD, these parameters, as well as the per cent T4 cells, serum bilirubin level, per cent retention of ICG at 15 minutes, and the plasma ICG disappearance rate were not found to be of substantial help in predicting patient survival or nonsurvival.

Moreover, neither the degree of HLA matching nor the number of rejection episodes differed between surviving and nonsurviving patients.

The results of this study suggest that patients with PLD are at increased risk of early postoperative death after OLTx because of bacterial and/or fungal sepsis, as compared with patients operated upon for ChLD. Better pre-, intra-, and postoperative predictors of risk of death and complications are

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needed to reduce the early mortality observed after orthotopic liver transplantation.

DUE TO A VARIETY of factors, such as better initial selection of candidates for the procedure, refinements in the techniques of organ procurement and surgical grafting, the introduction of cyclosporine A (CyA), and improvements in the pre- and postoperative management of such patients, the life expectancy of patients undergoing orthotopic liver transplantation (OLTx) has increased considerably over the last several years.¹ Recent data from our institution regarding survival show a 69.7 and 62.8% 1- and 5-year actuarial survival in 313 adult liver transplant patients.² The vast majority of the postoperative deaths have occurred within the first 2 postoperative months and are related primarily to sepsis.³ Rejection is also a frequent, albeit controllable, problem after OLTx.

The intensive immunosuppressive regimens used to treat rejection facilitate postoperative sepsis. Other factors, independent of the preoperative condition of the patient receiving a graft, might also play an important role in contributing to some of the postoperative deaths observed. Examples include ischemia of the graft and technical problems at the time of the operation that lead to postoperative vascular anastomotic thrombosis.

Because of these uncertainties, we have evaluated patients prospectively for liver transplant and have tried to identify immunologic, biochemical, and functional parameters that predict the frequency of rejection episodes, the chance of survival, and the cause of death, should death occur in these patients. The following is a report of our findings.

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Material and Methods

We studied all adult candidates who were evaluated for possible liver transplantation between September 1984 and September 1986. During this period, 150 adult patients received transplantations at the University of Pittsburgh. Ninety-eight of these patients had a protocol preoperative evaluation before the transplant and were considered for inclusion in the study. The remaining 52 patients were either evaluated at their own referring institutions or were sent directly to the surgical service (n = 42) and were either not evaluated completely or had acute hepatic failure that prohibited a complete preoperative evaluation (n = 10) before transplantation.

The indicators of need for OLTx in these 98 patients are shown in Table 1. Overall, we can divide these 98 patients into three distinct groups: a parenchymal liver disease group (PLD, n = 43), a cholestatic liver disease group (ChLD, n = 45), and a miscellaneous group (MISC, n = 10). The mean ± SEM age for the PLD patients was 33 ± 2 years (range = 17-59 yrs); 40 ± 2 years for the ChLD patients (range = 20-57 yrs); and 40 ± 4 years for the MISC (range = 21-52 yrs). The ratio of men to women was 1.3 for the PLD group, 0.7 for the ChLD group, and 1.2 for the MISC group.

The average interval between the initial evaluation and the subsequent OLTx was 4 months (range = 1 week-1 year); the average for patients with PLD, 3.0 ± 0.6 months, was shorter than it was for patients with ChLD, for whom it was 5.0 ± 0.6 months (p < 0.05).

The following biochemical and immunological parameters were determined for all candidates: serum bilirubin and albumin levels, prothrombin time (PT), total lymphocyte count and lymphocyte subsets determinations, and the patient's histocompatibility antigens (HLA). Both absolute numbers and the percentage of T lymphocytes and the various T lymphocyte subsets were determined. The T cell subpopulations were determined by flow cytometry on a FACS IV (Becton-Dickinson, Mountain View, CA), using a slight modification of the method described previously.⁴ The following fluorescent labeled anti-T cell surface marker monoclonal antibodies were used: T3 (OKT₃, Leu 4), T₄ (OKT₄, Leu 3 a + b), and T₈ (OKT₈, Leu 2a). (The OKT series was purchased from Ortho Diagnostics; the Leu series was purchased from Becton-Dickinson.) At least 5 × 10⁴ cells were analyzed for each monoclonal antibody determination. Control lymphocyte subset measurements were obtained in 100 contemporarily studied, normal patients.

In 80 of the 98 patients studied, peripheral blood lymphocytes of both the donor and the recipient were typed for HLA A, B, and DR antigens. The method used included the use of the standard National Institute of Health microlymphocytotoxicity technique for detec-

TABLE 1. Indicators of Need for Liver Transplantation (n = 98 patients)

Final		
PLD (n = 43)	Cirrhosis idiopathic	29
	Cirrhosis HBs +	4
	Cirrhosis Autoimmune	1
	Cirrhosis Wilson's	4
	Cirrhosis Hemochromatosis	2
	Cirrhosis Thorotrast	1
	Cirrhosis α-AT Def.	2
CLD (n = 45)	Primary Biliary Cirrhosis	24
	Primary Sclerosing Cholangitis	16
	Secondary biliary cirrhosis	3
	Caroli's disease	2
MISC (n = 10)	Multiple adenoma	1
	Hepatocellular carcinoma	4
	Subacute non-A, non-B (NANB) necrosis	2
	Budd-Chiari syndrome	1
	Polycystic kidney and liver	1
	Cryptococcosis	1

tion of A and B antigens and prolonged incubation microlymphocytotoxicity testing using enriched B-cell preparations obtained after carbonyl-iron treatment and Ficoll-H Hypaque sedimentation after rosetting with neuraminidase-treated sheep red blood cells for the detection of the DR antigens. HLA matching between donors and recipients was considered when an antigen present in the donor was also present in the recipient. Measurement of the plasma retention of Indocyanine green (ICG) at 15 minutes and its plasma disappearance rate, obtained after intravenous (I.V.) administration of the drug, were determined in 86 of the patients.

The following parameters were studied after OLTx: survival, cause of death, number of rejection episodes, hospitalization duration, the cyclosporine and prednisone dose (oral) given at discharge, and the last follow-up cyclosporine and prednisone dosage.

In regard to survival, five groups of patients were considered. Group A (n = 13) included patients dying during the first 6 postoperative weeks; Group B (n = 11) consisted of those dying between the 6th and 12th postoperative weeks; Group C (n = 3) consisted of those who died after the 12th postoperative week; Group D (n = 39) included patients who survived after a follow-up less of than 1 year, and Group E (n = 31) included patients who survived after a follow-up of more than 1 year. Two other patient categories were also evaluated: the 24 patients who died within 12 weeks of the transplantation procedure (Groups A and B combined) and the 70 patients who survived at least 12 weeks after the operation (Groups D and E combined).

A rejection episode was considered present when an elevation of bilirubin and/or gamma glutamyl transpeptidase occurred in the absence of biliary obstruction, or vascular thrombosis and resolved rapidly with the initiation of antirejection therapy. Histologic confirmation of

TABLE 2 Causes of Death, Numbers of Retransplantation, and Ratio of PLD/ChLD for Patients Undergoing OLTx Segregated as to Duration of Survival (n = 98 patients)

Cause of Death	Cause of Sepsis*				Retransplantation	PLD/ChLD Ratio	
	B	F	V	P			
Group A (n = 13)	Sepsis n = 10 Operative n = 2 Intracranial Hemorrhage n = 1	6	8	2	—	7	2.2
Group B (n = 11)	Sepsis n = 9 Rej. n = 1 Metastasis n = 1	2	1	3	2	7	0.8
Group C (n = 3)	Sepsis n = 2 Myoc. Infarct. n = 1	0	0	1	1	1	—
Group D (n = 39)	—	—	—	—	—	2	0.7
Group E (n = 32)	—	—	—	—	—	8	0.9

* B = bacteria.
F = fungus

V = virus.
P = protozoan (Pneumocystis)

presumed rejection was frequently obtained and was established through the use of criteria recently reported.⁵ At least one rejection episode occurred in each of 67 of the 98 patients studied and was diagnosed by clinical criteria in 22 (33%) and a combined clinico-histologic basis in 45 (67%). A typical antirejection regimen included a large I.V. dose of hydrocortisone or prednisolone with or without a 1-week steroid recycle.³ Since August 1984, the antirejection therapy has included OKT₃ administration, as well.

Before OLTx, Claforin (1 g of IV) was given to all patients. Ampicillin (1 g) and claforin (1 g) were given intravenously every 6 hours for 5 days; Mycostatin was given orally at identical intervals.

Twenty-seven patients died. A complete autopsy was obtained from 22. Generally, either the most prominent pathologic event found at the time of the autopsy or if an autopsy was not performed, the most important complication during the immediate preterminal clinical course was identified as the cause of death.

Pre- and postoperative data were entered in on an IBM™ computer. Analysis of variance (ANOVA), Spearman correlation, chi-square analysis, and Student's *t* test for paired and unpaired values were used in the statistical analysis of the data obtained using a Stat-pack™. Statistical significance was obtained when the *p* value was at least <0.05.

Results

Survival

The survival groups are represented in Table 2 as well as cause of death, the cause of sepsis, number of retransplantation when it occurred, and the ratio of PLD/ChLD cases for each group.

Thirteen per cent (13 of 98 patients) of the deaths observed occurred within 6 weeks of operation; 24% (24 of 98 patients) occurred within 12 weeks of the procedure. Only 3% (three of 97 patients) of the deaths occur more than 12 weeks after the time of surgery. Sepsis was the principle cause (79%; 19 of 24 patients) of death in those who died within 12 weeks of surgery. Bacterial and fungal sepsis was seen as the cause of death principally in those patients who died within the first 6 weeks, whereas viral and protozoal sepsis were the principal causes of death that occurred after 6 weeks ($X^2 = 6.6$; 95% Confidence Interval (CI) 2.1–121.3; $p < 0.01$). An odds ratio for deaths of 16.33 was obtained, showing that risk of early death (before 6 weeks) was increased sixteen-fold in those who developed an early postoperative bacterial and fungal infection.

A higher frequency of retransplantation was seen in Groups A and B as compared to Groups D and E (14 of 24 patients = 58% vs. 10 of 70 patients = 14%, $p < 0.05$). Interestingly, the PLD/ChLD ratio was higher in the Group A patients who died of early bacterial or fungal sepsis as compared to any of the other four groups ($X^2 = 5.1$; 95% CI 1.13–32.7; $p < 0.05$).

The percentage of patients operated upon for PLD, ChLD and MISC hepatic diseases who survived at 6 weeks, 12 weeks, and 1 year is shown in Figure 1. There was a rapid decline in patient survival in the PLD group during the first 6 postoperative weeks as compared to either of the other two patient groups. Overall, the percentage of patients who survived at any point was better for those in either the MISC or the ChLD categories than it was for those in the PLD group. Of particular interest, however, is the fact that after the initial 6 weeks, the survival curves for all three groups were essentially parallel (Fig. 1).

Pretransplant Immunological, Biochemical and Functional Evaluation

The pretransplant values for total lymphocytes and T lymphocyte subsets are shown in Table 3 and are compared with those of normal controls. Through this comparison, all mononuclear subsets were found to be decreased significantly in the liver transplant recipients. However, the T_4 (helper)/ T_8 (suppressor) ratio was significantly higher in the transplant recipients as compared to the controls, because of a relatively smaller reduction in the number of T_4 cells as compared to T_8 cells. These same pretransplant parameters separated the types of liver disease (PLD, ChLD, and MISC hepatic diseases). These data are shown in Table 4. It is apparent from this table that, compared to normal controls, patients with parenchymal liver disease had similar values for their percentage T_8 cells and resultant T_4/T_8 ratios. In contrast, their percentage T_4 cells was reduced modestly but significantly (Mean \pm SEM: 42.5 ± 1.9 vs. 49 ± 1.0 ; $p < 0.05$). As expected, their albumin and prothrombin time values were lower than those of controls, as well as those within the cholestatic or miscellaneous liver disease groups.

In contrast, patients with cholestatic liver disease have a lower percentage of T_8 (Mean \pm SEM: $16.2\% \pm 1.0$ vs. 24 ± 0.6 ; $p < 0.02$) and a resultant higher H/S ratio than did the controls (Mean \pm SEM: 3.4 ± 0.2 vs. 2.0 ± 0.1 ; $p < 0.005$). Their percentage T_4 cells was not different from that of the controls.

The per cent retention of ICG at 15 minutes and plasma ICG disappearance rates were not different between the three liver disease groups, but were markedly altered as compared to normal values (Table 4 and Fig. 2).

Relationship Between Survival Groups and the Various Assessed Immunologic, Biochemical and Functional Parameters Obtained before Surgery

Preoperative levels for T_4/T_8 , percentage of T_8 cells, percentage of T_4 cells, bilirubin, albumin, prothrombin time, percentage of ICG retained at 15 minutes, and plasma ICG disappearance rate (k) in patients who did

% SURVIVAL

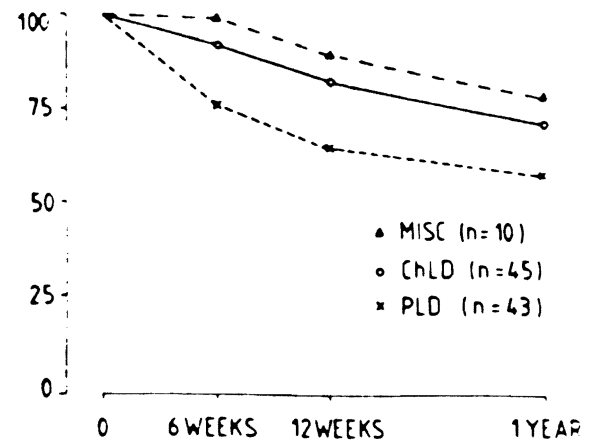


FIG. 1. Percentage of survival in relation to the final diagnosis liver disease.

not survive 12 weeks ($n = 24$) and those who did survive after 12 weeks ($n = 70$) are shown in Table 5.

None of these parameters was significantly different between the two groups. The ICG disappearance curves for these two groups of patients is shown in Figure 2 and is compared to that of normal controls.

Using analysis of variance, the same parameters were evaluated in the five survival groups. Again, there were no statistically significant differences between the different survival groups.

The degree of HLA-A and B (Class I), HLA-DR (Class II) and combined HLA-AB + DR antigen matches for each of the five different survival groups is shown in Table VI and Figure 3. No significant relationship was seen between the number of HLA matches and patient survival. In fact, what was noted was the marked lack of any agreement between the donors and recipients for either Class I or Class II antigens. Specifically, a rather low number of matches was observed; for example, a mean of 1.3, 0.9, 2.0, 1.3, and 1.3 HLA-A and B + DR matches out of a maximum of six possible matches, respectively, was seen in Groups A through E.

Interestingly, no correlation was obtained between the number of HLA matches and the number of rejection episodes experienced. Furthermore, no correlation was

TABLE 3. Pretransplant Values (Mean \pm SEM) of Lymphocytes, T Cells (T_3), Helper Cells (T_4), Suppressor Cells (T_8), and the T_4/T_8 Ratio in the 98 Transplant Patients Studied

	Lymphocytes		T_3		T_4		T_8		T_4/T_8 Ratio
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	
Patients (n = 98)	1015 \pm 75	17.3 \pm 1.0	642 \pm 54	61.9 \pm 1.8	456 \pm 39.5	44.4 \pm 1.4	172 \pm 15.5	17.2 \pm 0.8	3.0 \pm 0.1
Controls (n = 100)	1539 \pm 51	25.2 \pm 1.0	1174 \pm 49	67 \pm 0.7	795 \pm 28	49 \pm 1.0	397 \pm 15	24 \pm 0.6	2.0 \pm 0.1
p value	<0.005	<0.005	<0.005	<0.05	<0.005	<0.05	<0.005	<0.005	<0.005

TABLE 4. Pretransplant Values (Mean \pm SEM) of Lymphocytes, T_H Cells, T_S Cells, T_H/T_S Ratio, Albumin, PT, IS Min, and ICG Retention (A_{15}) and ICG Disappearance Rate (k) According to Underlying Liver Disease in the Patients Studied

	Number of Patients	% T_H	% T_S	% T_H	% T_S	T_H/T_S	Albumin (g%)	PT (s)	A_{15} (%)	k min
PLD	43	17.8 \pm 1.7	60.6 \pm 2.5	42.5 \pm 1.9†	23.6 \pm 3.2	2.5 \pm 0.2	2.7 \pm 0.1†	74.0 \pm 2.2†	51.9 \pm 2.7	0.012 \pm 0
ChLD	45	16.2 \pm 1	64.6 \pm 2.6	47.4 \pm 2.1	16.2 \pm 1.0*†	3.4 \pm 0.2*†	3.3 \pm 0.1*	86.0 \pm 1.9*	47.4 \pm 2.7	0.013 \pm 0
MISC	10	20.6 \pm 4	54.9 \pm 6.3	38.6 \pm 4	15.6 \pm 2.1	2.6 \pm 0.3	3.0 \pm 0.1	79.0 \pm 5	36.2 \pm 8.7	0.02 \pm 0
Controls	100‡	25.2 \pm 1.0	67.0 \pm 0.7	49.0 \pm 1.0	24.0 \pm 0.6	2.0 \pm 0.1	3.5 \pm 2.5	>85	<5	0.18 \pm 0

* Statistically different (at least $p < 0.05$) from PLD

† Statistically different (at least $p < 0.05$) from controls

‡ 100 control patients were studied for comparison of the immuno-

logical parameters. usual normal values for albumin and PT were considered. Results from five normal subjects without hepatic dysfunction were used for the ICG clearance studies

obtained between the number of lymphocytes or the number of various lymphocyte subsets and the number of rejection episodes experienced, the last hospitalization dosage of CyA and prednisone, the last follow-up dosage of CyA and prednisone or the duration of hospitalization. Moreover, the number of rejection episodes did not differ between the various survival groups (Mean \pm SEM: 1 \pm 0.4 in Group A; 1 \pm 0.4 in Group B; 0.3 \pm 0.3 in Group C; 1.7 \pm 0.3 in Group D; 1.2 \pm 0.2 in Group E).

Discussion

In this study, we tried to identify the pretransplantation-obtained immunological, biochemical and functional parameters that might be of help in predicting the ultimate outcome of the procedure. Only those parameters that could be obtained as part of a systematic routine pretransplant work-up were considered for evaluation. It has been shown that patients with hepatic failure due to any cause severe enough to warrant liver transplantation have abnormalities in the number and percentage of cells in each of the various mononuclear cell subsets. As far as cellular immunity parameters are concerned, patients with ChLD as compared to normal controls and patients with PLD have significantly higher pretransplant helper-suppressor ratios, primarily be-

cause of a relative reduction in the number of their T_S (suppressor) cells. Moreover, patients with PLD have normal helper/suppressor ratios, but also have a modest reduction in the percentage of T_H (helper) cells. These facts confirm earlier data⁶⁻⁷ that suggest that primary biliary cirrhosis and sclerosing cholangitis behave like other autoimmune diseases and have an increased helper-suppressor cell ratio. It is presumed, although not established, that this occurs because the T_H cells leave the vascular compartment to colonize the liver and accumulate and exert their effects at the site of their target antigens within the liver.⁸

Biochemically, the patients with PLD considered for transplantation present with lower albumin and more abnormal prothrombin times as compared to patients with ChLD. On the other hand, hepatic function as determined by indocyanine green clearance did not differ between the two groups. Patients with ChLD had a better survival rate than did patients with PLD. Their 6-week, 8-week, and 1-year survival figures of patients with ChLD are 93%, 82%, and 73%, respectively—in contrast with those of patients with PLD who have survivals of 77%, 65%, and 57% at these same respective time points. It is also evident from our data that this difference is caused principally by an increased number

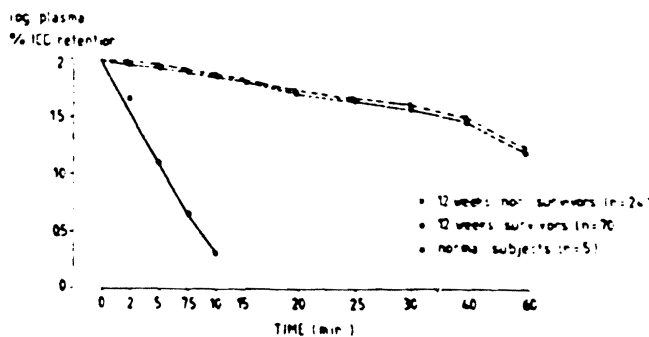


FIG. 2. Log plasma percentage ICG retention in relation to time in normal subjects ($n = 5$) as compared to patients who survive ($n = 70$) and those who do not survive ($n = 24$) transplantation.

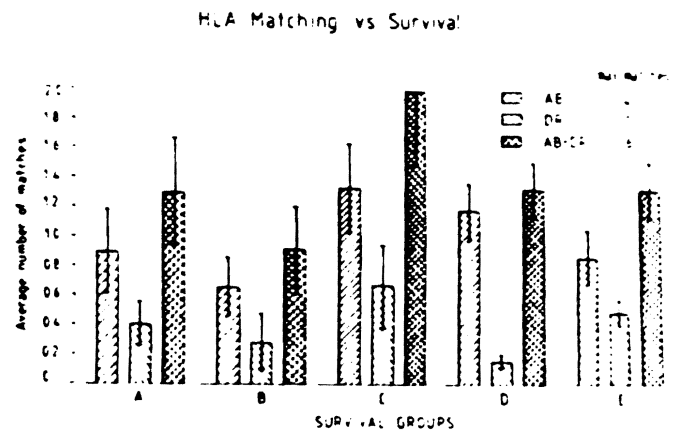


FIG. 3. Comparison between survival groups and degree of pretransplant HLA matches with donor (mean \pm SEM) ($n = 82$).

of postoperative deaths occurring in patients with PLD within the first 6 postoperative weeks.

Overall, mortality in the present series was 27% (27 of 98 patients), most of which occurred during the first 12 postoperative weeks. It should also be emphasized that among the Group A patients (those dying within 6 weeks of operation), twice as many patients had PLD as had ChLD, whereas a ratio of less than one was present in the four other survival groups. Moreover, bacterial and fungal sepsis were the two major causes of death in the Group A patients.

It is not unreasonable to think that the mechanisms responsible for protecting the individual against bacterial infection that are particularly deficient in patients with advanced PLD as compared to CLD normalize with the successful engraftment of a functioning liver.

However, as graft dysfunction frequently persists, at least to some degree, during the first 2 postoperative weeks, it is also probable that any pre-existing abnormality in host defense mechanisms will persist or become even less effective for a short period after OLTx, thereby rendering the patient even more susceptible to bacterial and/or fungal sepsis. Because it has been shown to influence cellular immune response mechanisms,^{9,10} poor nutrition could also be implicated and could aggravate a pre-existing reduction in helper cell function present in liver transplant patients, occurring as a consequence of either their primary hepatic disease or the immunosuppression therapy that they require.

The fact that a reduced serum albumin level is related to greater blood losses experienced during the first phase (dissection) of OLTx procedure¹¹ and that the preoperative coagulation profile is more severely altered in patients with PLD than it is in patients with ChLD,¹² is consistent also with the observation of a greater postoperative mortality in patients with parenchymal liver disease than those with cholestatic liver disease. It remains to be shown however that the preoperative correction of preexisting nutritional abnormalities present in PLD patients improves the survival of these patients following OLTx.

Unfortunately, immunological biochemical and functional parameters of liver function obtained before

TABLE 5. Comparison Between 12-Week Nonsurvivors and 12-Week Survivors in Terms of Pretransplant Values of T_4/T_8 , % T_4 Cells, % T_8 Cells, Bilirubin, Albumin, PT, % ICG Retention, X_1 , and ICG Disappearance Rate k (Mean \pm SEM)

	12-Week Nonsurvivors (n = 24)	12-Week Survivors (n = 70)	p Value
T_4/T_8	2.6 \pm 0.3	3.0 \pm 0.2	NS
% T_4 cells	44.4 \pm 2.2	43.9 \pm 1.6	NS
% T_8 cells	20.0 \pm 1.8	16.6 \pm 0.8	NS
Bilirubin (mg/dl)	12.2 \pm 3.0	12.3 \pm 4.0	NS
Albumin (g/dl)	2.85 \pm 0.12	3.0 \pm 0.07	NS
PT (%)	76.0 \pm 2.0	82.0 \pm 2.0	NS
X_1 (%)	50.8 \pm 3.5	47.3 \pm 2.5	NS
k (min ⁻¹)	0.012 \pm 0.002	0.013 \pm 0.0008	NS

NS = no significant difference.

surgery do not appear to help substantially in predicting survival after OLTx. When comparing patients who survive for greater than 12 weeks (those in Groups D and E) with the patients who survive less than 12 weeks (those in Groups A and B), no differences in the levels of albumin, bilirubin, prothrombin time, T_4/T_8 ratio, percentage of T_4 cells, percentage of T_8 cells, and the plasma ICG disappearance rate were evident. However, it should be pointed out that the deaths that occurred after the initial 6 weeks occurred primarily as a result of a viral or protozoal infection and are, most likely, a consequence of the immunosuppression used, rather than a consequence of some pre-existing biological or immunological variable determined before surgery that may exist in the study population.

However, despite how dissatisfying the present data are, they do identify parameters that do not appear to be involved in determining survival after OLTx—that is, the number of rejection episodes and/or the number of HLA mismatches. This is true despite the fact that it is generally held that the HLA antigens of Class I (A, B) and Class II (DR) loci are thought to be strong transplantation antigens and to play an important role in the initiation of the rejection process.

A recent publication on more than 8000 kidney transplant procedures collected from all over the world documents the relationship between survival and the

TABLE 6. Comparison Between Survival Groups and Degree of Pretransplant HLA Matches with Donor (Mean \pm SEM; n = 82)

	Group A (n = 10)	Group B (n = 11)	Group C (n = 3)	Group D (n = 27)	Group E (n = 21)
HLA-AB (perfect match = 4.0)	0.9 \pm 0.3	0.6 \pm 0.2	1.3 \pm 0.3	1.2 \pm 0.2	0.9 \pm 0.2
HLA-DR (perfect match = 2.0)	0.4 \pm 0.1	0.3 \pm 0.2	0.7 \pm 0.3	0.15 \pm 0.1	0.5 \pm 0.1
HLA-AB + DR (perfect match = 6.0)	1.3 \pm 0.4	0.9 \pm 0.3	2.0 \pm 0.5	1.3 \pm 0.2	1.3 \pm 0.2

degree of HLA matching in kidney transplantation¹³. Certainly it is possible that the smaller number of OLTx cases studied and the deliberate failure to search for the best possible match in liver transplant cases are important elements that contribute to the differences observed between kidney and liver transplantation data relative to this issue.

Considering all of the data available, the present study highlights the overall good results experienced with OLTx for end-stage liver disease and contributes to the growing confidence in pursuing liver transplantation as the treatment of choice for a variety of liver diseases with irreversible advanced hepatic failure.

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