



Does Valganciclovir Hydrochloride (Valcyte) Provide Effective Prophylaxis Against Cytomegalovirus Infection in Liver Transplant Recipients?

A. Jain, M. Orloff, R. Kashyap, K. Lansing, R. Betts, R. Mohanka, M. Menegus, C. Ryan, and A. Bozorgzadeh

ABSTRACT

Introduction. Cytomegalovirus (CMV) infection after solid organ transplantation is one of the most common viral infections, causing significant morbidity and mortality if not treated promptly. Ganciclovir has proven to be effective for the prophylaxis and treatment of CMV. However, oral absorption of ganciclovir is poor. Recently, oral administration of valganciclovir hydrochloride (Valcyte) has been observed to display 10-fold better absorption than oral ganciclovir. Valganciclovir has increasingly been used as prophylaxis against CMV after solid organ transplantation. The purpose of this study was to examine the efficacy of valganciclovir prophylaxis therapy after primary liver transplantation.

Patients and Methods. Between July 2001 and May 2003, 203 consecutive liver transplant recipients, including 129 men and 74 women of overall mean age 53 ± 11 years, received valganciclovir (900 mg/d or 450 mg every other day depending on renal function) for 3 to 6 months after primary liver transplantation. All patients were followed up for a minimum of 6 months. Mean follow-up was 19 ± 5.8 months. CMV DNA in peripheral blood was tested using polymerase chain reaction (PCR) amplification. Symptomatic CMV was stratified according to the CMV immunoglobulin (Ig)G status of the donor and recipient at the time of liver transplantation. Donors and recipients were classified preoperatively into groups according to the presence or absence of CMV as follows: group 1 (n = 73; donor CMV+, recipient CMV+); group 2 (n = 41; donor CMV-, recipient CMV+); group 3 (n = 54; donor CMV+, recipient CMV-; high-risk group); and group 4 (n = 35; donor CMV-, recipient CMV-).

Results. Twenty-nine patients (14.3%) developed symptomatic CMV disease at 169 ± 117 days after liver transplantation: group 1, 16.4% versus group 2, 7.3% versus group 3, 25.9% versus group 4, 0%. Of these patients, 5 also had invasive CMV on liver biopsy, which was performed owing to abnormal liver functions. All 29 patients were treated with intravenous ganciclovir. One patient died owing to disseminated CMV, whereas the remaining 28 patients responded to treatment. Interestingly, 8 patients, including 1 who had invasive CMV hepatitis, developed symptomatic CMV within 90 days of liver transplantation even while on prophylactic valganciclovir.

Conclusion. Valganciclovir failed to provide adequate prophylaxis following liver transplantation in our patients. The overall rate of CMV in seropositive donors and/or recipients was 17%, and in the high-risk group was 26%. Further prospective studies with measurement of ganciclovir concentrations are needed to elucidate the reasons for this unexpected failure.

From the Department of Surgery, Transplant Division, University of Rochester, Rochester, NY, USA.

Address reprint requests to Ashokkumar Jain, MD, 601 Elm-

wood Ave, Box SURG, Rochester, NY 14642, USA. E-mail: Ashok_Jain@urmc.rochester.edu

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360 Park Avenue South, New York, NY 10010-1710

THIS STUDY sought to examine the efficacy of a 3- to 6-month course of prophylactic valganciclovir therapy in adult patients following primary liver transplantation. Cytomegalovirus (CMV) infection is one of the most common viral infections after solid organ transplantation. If CMV infection is not treated effectively in these patients, it leads to significant postoperative morbidity and mortality.¹⁻⁴ Ganciclovir has proven to be effective in the treatment and prophylaxis of CMV infection.⁵ Various protocols to prevent CMV infection following liver transplantation have been reported.⁶⁻¹⁰ 2-week short-term course of intravenous ganciclovir followed by 12-week long-term treatment orally has been observed by some investigators to be an effective treatment protocol.¹¹⁻¹⁵ However, <8% of ganciclovir is absorbed after oral administration; therefore, it is not suitable for prophylaxis or treatment of CMV infection.

Recently, valganciclovir hydrochloride (Valcyte) has been observed to display 10-fold greater absorption after oral administration compared with oral ganciclovir. Pharmacokinetic studies have shown that a single oral dose of 450 mg valganciclovir has the equivalent bioavailability of ganciclovir 1 g t.i.d. In addition, a single oral dose of valganciclovir (900 mg) is equivalent in area under the curve (AUC) to that of 5 mg/kg/d intravenous ganciclovir. Prophylactic use of valganciclovir for 3 months following solid organ transplantation prevents reactivation or superinfection from CMV disease.^{4,5,7,12}

PATIENTS AND METHODS

Between July 2001 and May 2003, 203 consecutive liver transplant recipients (129 men, 74 women; mean age, 53 ± 11 years) received valganciclovir prophylaxis for 3 to 6 months (900 mg/d or 450 mg every other day, depending on renal function). All patients were followed up for a minimum of 6 months. Mean follow-up was 19 ± 5.8 months. Routine surveillance to detect CMV DNA in peripheral blood was not performed unless patients were symptomatic, in which case CMV DNA in peripheral blood was tested using polymerase chain reaction (PCR) amplification.¹⁶ The rate of symptomatic CMV was stratified according to pre transplantation donor and recipient CMV immunoglobulin (Ig)G antibody status. CMV IgG titers >1:20 were considered positive. The population was divided into 4 groups as follows: group 1 (n = 73; donor CMV+, recipient CMV+); group 2 (n = 41; donor CMV-, recipient CMV+); group 3 (n = 54; donor CMV+, recipient CMV-); and group 4 (n = 35; donor CMV-, recipient CMV-).

Immunosuppression

All patients received tacrolimus, mycophenolate mofetil (MMF), and steroids. Tacrolimus was given orally every 12 hours at a dosage of 0.1 mg/kg/d. Target 12-hour trough whole blood tacrolimus concentrations were 12 ng/mL in the first month, 10 ng/mL in the second month, 8 ng/mL in the third month, and 6 ng/mL beyond 3 months. MMF (1 g) was administered orally twice a day. One gram of methylprednisolone was given intraoperatively prior to reperfusion of the liver allograft, followed postoperatively by a steroid taper totaling 600 mg during the next 5 days. Subsequent immunosuppressive adjustments were made based on the individ-

ual's clinical course considering the presence of signs of rejection, drug toxicity, or infection.

RESULTS

During follow-up, 29 patients (14.3%) developed systemic CMV, of which 5 patients had invasive CMV on liver biopsy. Mean time to develop CMV infection was 169 ± 117 days (median, 174 days) following liver transplantation. Eight patients developed CMV while on valganciclovir prophylaxis within the first 3 months after liver transplantation. As expected, the highest incidence of symptomatic CMV was observed in group 3, in which 14 of 54 patients (25.9%) developed febrile illness from CMV infection. Rates of CMV infection were 16.4% (n = 16) in group 1, 7.3% (n = 3) in group 2, and 0% (n = 0) in group 4 (Table 1).

Of 29 patients who developed CMV, 2 (6.9%) experienced acute episodes of rejection requiring an additional bolus of steroid before CMV illness. All acute rejections responded to steroid therapy and none required antibody therapy.

Five patients were diagnosed with invasive CMV on liver biopsy, which was performed due to elevated biochemical parameters indicative of hepatic dysfunction. Immunohistochemical studies were positive for CMV in all 5 patients. Most patients with CMV infection responded to intravenous ganciclovir with the exception of 1 patient with invasive CMV hepatitis, who died of widespread, systemic CMV. Liver function at the time of invasive CMV hepatitis and at last follow-up is shown in Table 2. Figure 1 shows hematoxylin and eosin as well as immunohistochemical stains showing inclusion bodies confirming CMV hepatitis among patients who developed CMV hepatitis on day 30 while on valganciclovir.

DISCUSSION

Approximately 70% of the population is exposed to CMV before adulthood. These individuals exhibit mild viral-like symptoms. Most of these individuals develop the IgG antibody for CMV; the virus remains dormant in the body.³ When a host immune system is compromised by immunosuppressive agents, as is the case in solid organ transplantation, CMV can reactivate. The resulting viremia, if not controlled, can invade any organ system and may be life-threatening. In patients without previous virus exposure (CMV IgG- ve) who receive an organ from a donor that has been exposed (CMV IgG+ ve), there is a higher risk of

Table 1. Patient Distribution by CMV IgG Status

Group	Donor IgG	Recipient IgG	No. of Patients	CMV Infection No. (%)	Mean Days to CMV
1	+	+	73 (35.9)	12 (16.4)	99 ± 101
2	-	+	41 (20.1)	3 (7.3)	313 ± 161
3	+	-	54 (26.6)	14 (25.9)	192 ± 83
4	-	-	35 (17.2)	0 (0)	NA

Abbreviation: NA, not applicable.

Table 2. Characteristics of Patients with CMV Hepatitis

No.	Gender M/F	Diagnosis	Group	Days to CMV	T Bilirubin		AST		ALT		ALKP		GGTP		Survival Last Follow-Up
					Before	After	Before	After	Before	After	Before	After	Before	After	
1	M	Hepatitis C viral infection	R+/D+	185	12.6	NA	119	NA	116	NA	272	NA	218	NA	Died after 19 months after disseminated CMV
2	M	Alcohol-induced cirrhosis	R+/D+	30	1.1	1.4	166	159	245	215	571	242	1028	1723	Alive for 13 months post-CMV hepatitis
3	F	Hemochromatosis	R-/D+	407	0.9	NA	22	NA	11	NA	101	NA	210	NA	Died 28 months post-CMV from sepsis
4	F	Alcohol-induced cirrhosis	R-/D+	175	0.5	0.6	44	30	34	26	100	129	62	69	Alive for 20 months post-CMV hepatitis
5	F	Alcohol-induced cirrhosis	R-/D+	178	0.2	0.7	505	81	506	65	90	63	156	21	Alive for 19 months post-CMV hepatitis

Abbreviations: M, male; F, female; T Bilirubin, total bilirubin mg/dL; AST, aspartate aminotransferase u/L; ALT, alanine amino transferase u/L; ALKP, alkaline phosphatase u/L; GGTP, gamma glutamyl transferase u/L; NA, not applicable; R, recipient; D, donor.

developing CMV illness transmitted via the donor organ. When both donor and recipient are CMV-ve, the recipient may still acquire de novo CMV infection, as in the past, through a blood transfusion from CMV+ donors. Because blood transfusions are now leukocyte depleted, this type of viral transmission is rare.

Before the advent of ganciclovir, many patients developed symptomatic and invasive CMV infections resulting in morbidity and death after solid organ transplantation. In CMV-infected cells, ganciclovir is initially phosphorylated to ganciclovir monophosphate by the viral protein kinase.¹⁴ It is then converted to ganciclovir triphosphate by cellular kinase. Ganciclovir triphosphate inhibits viral DNA synthesis. Mean bioavailability of oral ganciclovir is 6.2%–8.5%, hence, it has not been very effective in the treatment of CMV disease. However, large doses of oral ganciclovir (1 g t.i.d.), preceded by 2 weeks of intravenous ganciclovir, have been found to be an effective prophylaxis in preventing CMV disease in posttransplantation recipients.¹¹

Prospective studies using various protocols appear in the literature consisting of oral ganciclovir, oral high-dose acyclovir, intravenous ganciclovir for 2 weeks followed by 3 months of oral ganciclovir, or high-dose acyclovir. There are data related to antiviral prophylaxis for all cases of posttransplantation patients and for high-risk patients only.^{6–10} Furthermore there is evidence suggesting the benefit of preemptive therapy either with high-dose oral ganciclovir or intravenous ganciclovir based on the appearance of CMV pp65 in peripheral leukocytes or evidence of CMV DNA viral replication.^{10,17–20} All protocols, which include 3 months of treatment with ganciclovir, have been observed to be superior to high-dose acyclovir. Valganciclovir, an L-valyl (prodrug) of ganciclovir, is a mixture of 2 diesterases. After oral administration, both diesterases are reported to be converted rapidly to ganciclovir by intestinal and hepatic esterases. Absorption of valganciclovir has been found to be 10 times higher compared with oral ganciclovir, with bioavailability of nearly 60% in healthy volunteers and in patients who are human immunodeficiency virus (HIV) positive with CMV.^{14,21} Based on these findings, the greater absorption and antiviral activity of valganciclovir offers an attractive option for prophylaxis against CMV after solid organ transplantation.

As prophylaxis against CMV in all patients, since July 2001, we have used oral valganciclovir at doses of 900 mg/d or 450 mg every other day depending on renal function, for 3 to 6 months starting within 3 days after liver transplantation. To our surprise, some patients still developed CMV infection with a febrile illness despite prophylactic treatment at the time of infection. The use of an antibody preparation to prevent steroid-resistant rejection or of a steroid bolus to treat rejection increased the susceptibility to CMV among liver transplant recipients.²² Further examination of 29 patients who developed symptomatic CMV infection revealed that only 2 patients had received a steroid bolus to treat acute rejection, whereas the remaining 27 had no obvious added risk factors. It remains unclear

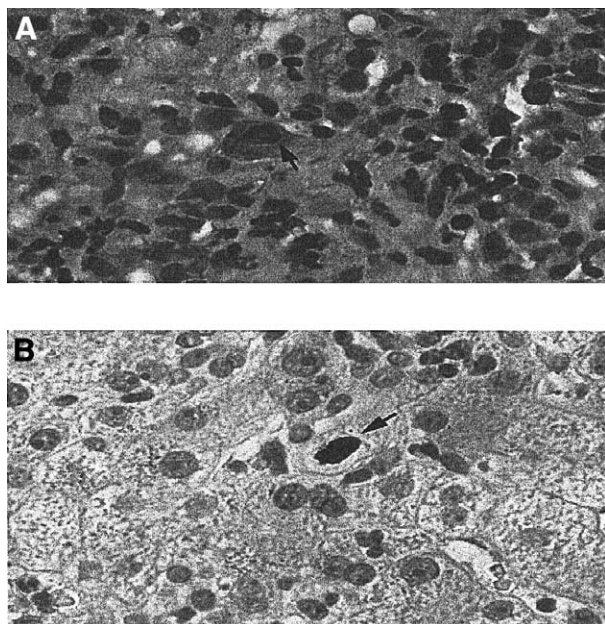


Fig 1. CMV hepatitis while on valganciclovir prophylaxis. (A) Hematoxylin and eosin stain for CMV hepatitis showing (arrow) inclusion body. (B) Immunohistochemical stain from the same patient confirming CMV antigen (arrow).

why the drug failed to demonstrate the much-anticipated efficacy.

Recently, a double-blind, prospective trial was completed in 372 posttransplantation patients (heart, $n = 56$; liver, $n = 177$; kidney, $n = 120$; and kidney/pancreas, $n = 11$) as high risk for CMV disease.¹⁴ Patients were randomized in a 2:1 ratio to receive either oral Valganciclovir (900 mg) or oral ganciclovir (1 g t.i.d.), starting within 10 days of transplantation, until the 100th day posttransplantation. A 6-month analysis reported the ratio of CMV disease or invasive CMV to be 12.1% among patients on valganciclovir prophylaxis versus 15.2% among those on ganciclovir. Interestingly, the incidence of CMV disease and invasive CMV in liver transplant recipients was higher compared with other transplant recipients with valganciclovir prophylaxis (19% versus 14%, respectively) versus oral ganciclovir prophylaxis (12% vs 3%, respectively).

Based on these findings, valganciclovir is no longer recommended for CMV prophylaxis in liver transplant recipients, but continues to be recommended for heart, kidney, and kidney/pancreas transplantation. These findings are similar and complimentary to our findings, but do not explain the occurrence of CMV disease despite valganciclovir prophylaxis. The proposed mechanism of drug action is the conversion of valganciclovir to ganciclovir by an esterase. We hypothesize that the esterase may be deficient or inefficient in the post-liver transplantation population owing to either hepatic dysfunction, bowel dysfunction, or both. Concurrent use of MMF, which also requires the esterase to convert to mycophenolic acid (MPA), might be

contributory. It is also important to note that when kinetic studies were conducted for oral dosing of valganciclovir, a prolonged presence of valganciclovir was detected in the samples. There are insufficient data on kinetic studies of valganciclovir in the immediate posttransplantation population. In a study of 28 patients by Pescovitz et al, kinetic studies were not performed until 21 to 180 days after transplantation.^{23,24} Further evaluation is needed to determine the relative ineffectiveness of valganciclovir in liver transplant recipients compared with other solid organ transplant recipients.

In conclusion, despite adequate recommended prophylactic doses of valganciclovir, the overall rate of symptomatic CMV was 17.3% when either donors or recipients were positive for CMV antibody. This suggests an ineffectiveness of oral valganciclovir prophylaxis for prevention of systemic CMV in liver transplant recipients. We suggest that this results from a biochemical inability to convert valganciclovir to active ganciclovir in the presence of hepatic or bowel dysfunction during the period after liver transplantation. Further evaluation is required to determine the etiology of this problem.

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