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Cytomegalovirus disease in African-American kidney transplant patients

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Abstract

Background—Cytomegalovirus (CMV) disease is a serious infection after kidney transplantation. The risk factors and the impact of CMV disease in African-American (AA) kidney transplant patients have not been well characterized.

Methods—We performed a retrospective analysis on 448 AA patients transplanted between 1996 and 2005. A 3-month universal chemoprophylaxis with ganciclovir or valganciclovir was administered to CMV donor-positive/recipient-negative (D+/R–) patients and to those treated with anti-thymocyte globulin for rejection, but not routinely to patients with other D/R serostatus.

Results—A total of 31 AA patients (7%) developed clinical CMV disease. Compared to other D/R serostatus, the D+/R– group had the highest 3-year cumulative incidence of CMV disease (16.9% vs. 6.3% in D+/R+, 4.9% in D–/R+, and 2.4% in D–/R–). The D+/R– group had the worst 3-year death-censored graft survival by Kaplan-Meier methods (75% vs. 92% in D+/R+, 94% in D–/R+, and 96% in D–/R–, $P=0.01$). Multivariate analysis found that D+/R– serostatus (odds ratio [OR] 5.4, 95% confidence interval [CI] 0.6–48.2, $P=0.003$) and donor age > 60 years (OR 9.1, 95% CI 1.3–65, $P=0.03$) were independent risk factors for CMV disease.

Conclusion—The D+/R– group has the highest incidence of CMV disease and the worst 3-year renal graft survival, in spite of the 3-month universal prophylaxis. Prolonged chemoprophylaxis may be needed to prevent the late development of CMV disease and to improve graft survival in the high-risk group of AA kidney transplant recipients.

Keywords

cytomegalovirus; graft survival; CMV prophylaxis; kidney transplant; African-American

Cytomegalovirus (CMV) was first isolated from a kidney transplant recipient in 1965 (1). CMV disease is associated with high morbidity and mortality after kidney transplantation

(1-5). It not only causes direct injury to the infected organs and tissues (such as CMV pneumonitis, colitis, hepatitis, encephalitis, nephropathy), but CMV disease also has indirect effects on the allograft, including acute rejection, chronic allograft nephropathy, and graft loss (3-6). It has been proposed that CMV may even play a role in the pathogenesis of cardiovascular disease and other opportunistic infections (5-8).

The highest risk group for developing CMV disease are CMV-seropositive donor kidneys transplanted into CMV-seronegative recipients (D+/R-) and those receiving T-cell depleting antibody induction and/or treatment for rejection (6, 9-12). Other risk factors may include simultaneous pancreas-kidney transplantation, old donor age, delayed graft function, and zero human leukocyte antigen (HLA)-DR match (2, 10, 13). Three-month chemoprophylaxis with ganciclovir (GCV) or valganciclovir (VGCV) traditionally has been used in high-risk patients. CMV prophylaxis has been shown to improve the transplant outcome and graft survival (3, 4, 14). However, the risk factors and the impact of CMV disease have not been well studied in African-American (AA) patients after kidney transplantation.

In this study, we retrospectively analyzed the clinic characteristics and risk factors of CMV disease, as well as its impact on graft survival in AA patients.

Materials and methods

Study population

This study was performed with an Institutional Review Board-approved protocol. Our transplant center database was cross-referenced with a United Network for Organ Sharing requested database for all AA recipients transplanted with primary single kidneys from January 1996 through December 2005. All patients were transplanted >3 years before the study was conducted.

Immunosuppression

All patients were treated with standard triple immunosuppression: steroids, a calcineurin inhibitor (tacrolimus or cyclosporine), and a mycophenolic acid (mycophenolate mofetil or enteric-coated sodium mycophenolate). Intravenous methylprednisolone was administered prior to reperfusion and tapered to 5 mg of prednisone by the third month. Tacrolimus doses were adjusted to keep the 12-hr trough levels between 8 to 10 ng/mL for the first 3 months, 6 to 8 ng/mL for the remainder of the first year, and 4 to 6 ng/mL thereafter. Cyclosporine trough levels were 175–225 ng/mL for the first 3 months, 125–175 ng/mL for the remainder of the first year, and 75–125 ng/mL thereafter. Each patient received either mycophenolate mofetil at 1 g or enteric-coated sodium mycophenolate at 720 mg twice daily. Rapamune was used to replace calcineurin inhibitor or mycophenolic acid for significant intolerance or adverse effects. High immunologic risk patients, defined as those with a 6-antigen HLA mismatch, and/or a panel reactive antibody >20%, received a standard 2 doses of the interleukin (IL)-2 receptor antagonist basiliximab as induction therapy. All patients were followed-up closely for life at our center, including scheduled routine labs and clinic visits. Patients with acute illness were usually directly admitted or transferred to our center, and all outside clinical and hospital events were reviewed carefully.

CMV disease prophylaxis and treatment

Universal CMV chemoprophylaxis was only given to patients with D+/R- discordant serostatus as well as to patients who received anti-thymocyte globulin (ATG) for treating acute rejection. The regimen included parenteral GCV (5 mg/kg twice daily) during hospitalization followed by oral GCV (1000 mg 3 times daily) or VGCV (900 mg once daily) for a total of 3 months. The dosage was adjusted according to renal function. VGCV was used since July 2004 for patients who could afford it financially. We did not routinely screen for CMV infection by viral surveillance during this study period; therefore, patient groups with other D/R serostatus received neither routine chemoprophylaxis, nor preemptive therapy. CMV disease was a clinical diagnosis, based on the combination of typical clinical presentation and positive viral detection evidenced by circulating CMV antigenemia, PCR of viral DNA level or viral invasion in biopsied tissues. Late onset CMV disease was defined as CMV disease diagnosed 3 months after kidney transplantation. All cases of CMV disease were treated with a 2- to 4-week course of parenteral GCV followed by 3 months of oral GCV or VGCV. The maintenance immunosuppression was usually lowered after the diagnosis of CMV disease.

Additionally, CMV hyperimmune globulin was administered to those with severe tissue invasive CMV disease. All patients received sulfamethoxazole/trimethoprim for 1 year and clotrimazole for 3 months. Acyclovir was used to treat clinical herpes simplex virus (HSV) disease and to prevent recurrent HSV disease. In our center, acyclovir was not routinely used to prevent HSV disease/infection immediately after transplant.

Outcome measure

Outcome measures included the following: 1) incidence and onset of CMV disease, 2) risk factors of CMV disease, and 3) patient and death-censored graft survivals over 3 years. Patient death included all mortalities from the time of transplantation. Graft loss was defined by primary non-function or loss of renal function requiring chronic dialysis.

Statistical method

Statistical analyses were performed using SAS version 9.1.3 software (SAS, Cary, North Carolina, USA). Chi-square or Fisher's exact test was used for count data and t-test for continuous measures. Product-limit estimates of survival curves were generated by the Kaplan-Meier method, and the survival difference was analyzed by log rank test. Univariate analysis and multivariate logistic regression analysis with a stepwise variable selection were used for examining risk factors for CMV disease. A *P*-value < 0.05 was considered statistically significant.

Results

During the study period, a total of 448 AA patients received a primary single kidney transplant in our center. Table 1 summarizes the demographic characteristics, immunosuppressive medications, and cumulative incidence of biopsy-confirmed and clinically treated acute rejection of patients who developed CMV disease and those who did not develop CMV disease after transplant. There were no significant differences in

demographic characteristics or immunosuppressive therapy between the 2 groups. There were numerically, but not statistically, higher incidences of acute rejection and ATG treatment for rejection in the CMV disease group (Table 1).

A total of 31 patients developed CMV disease (7%) that required clinical treatment in the first 3 years after kidney transplant. The distribution and 3-year cumulative incidences of CMV disease are shown in Table 2. The highest incidence of CMV disease was seen in the D+/R- group (16.9%). Nine of the 10 CMV cases in the D+/R- group were late onset and diagnosed 3 months after kidney transplantation. Another one was a “breakthrough” CMV disease, likely due to inadequate dosing of GCV when renal graft function had improved. Among the 9 cases of late onset CMV disease in the D+/R- group, 4 cases developed at 1, 3, 6, and 11 months respectively after treatment of acute rejection (2 treated with steroids only, 2 with additional ATG); and 3 cases were diagnosed at 2, 3, and 7 months respectively, before acute rejection was confirmed by kidney biopsies.

Demographic, clinical, and treatment variables were assessed as risk factors for developing CMV disease (Table 3). Univariate analysis demonstrated 4 significant factors of risk: D+/R- – discordant serostatus, donor age > 60 years, acute rejection, and tacrolimus usage. These factors were further analyzed by multivariate modeling to identify independent risk. D+/R- serostatus (odds ratio [OR] 5.4, 95% confidence interval [CI] 0.6-48.2, $P=0.003$) and donor age > 60 years (OR 9.1, 95% CI 1.3-65, $P=0.03$) were found to be the independent risk factors for CMV disease.

Death-censored graft survival was estimated by Kaplan-Meier analysis (Fig. 1). The 3-year graft survival was best (96%) in the D-/R- group and worst (75%) in the D+/R- group. The other two groups had intermediate graft survivals (92% in the D+/R+ group, 94% in the D-/R+ group). The log-rank test showed that there was a significant difference in the 3-year graft survival across the 4 groups ($P = 0.01$). No significant difference was seen in the 3-year patient survival among the 4 groups (100% in D-/R-, 98% in D-/R+, 97% in D+/R-, and 95% in D+/R+ group, log rank $P = 0.67$).

Discussion

The D+/R- CMV serostatus is commonly recognized to have the highest risk of developing CMV disease after kidney transplant, while D+/R+ and/or D-/R+ have moderate risk, and D-/R- has the lowest risk (1-4, 6, 9). There are 2 approaches for preventing CMV disease in high-risk patients: universal chemoprophylaxis or preemptive treatment (3-5). In our institution, 3-month universal prophylaxis with GCV or VGCV was administered immediately after transplant to all recipients with D+/R- CMV seromismatch. Other patients (D+/R+, D-/R+ and D-/R- groups) were not routinely given any CMV prophylaxis except when they were treated with a T-cell-depleting antibody, ATG, for acute rejection.

AA ethnicity is usually considered a risk factor for poor outcome after kidney transplant. It has been well documented that AA patients have a higher incidence of rejection and inferior graft survival. Numerous factors have been proposed to explain this poor outcome, including social and economic status, immunological features, and drug metabolism (15-17).

However, the impact of CMV disease on graft outcome in AA patients has not been well studied. In this study, we analyzed the clinical features and risk factors of CMV disease and its consequences at a large cohort of AA recipients in the era of modern immunosuppression.

Our data indicate that 3-month universal CMV chemoprophylaxis in D+/R- patients delays the onset of CMV disease, but does not effectively prevent it. There was only 1 case of “breakthrough” CMV disease in the D+/R- group during the chemoprophylaxis, which was explained by inadequate dosing of GCV when the patient's renal function had improved. Compared with all other D/R serostatus groups without routine chemoprophylaxis, D+/R- recipients still have the highest incidence of CMV disease, despite the universal prophylaxis in this group, and this serostatus is an independent risk factor for CMV disease. More importantly, we identified that the D+/R- group has the worst 3-year graft survival among all four groups, suggesting that the 3-month protocol of CMV chemoprophylaxis is inadequate for the D+/R- group. Prolonged CMV prophylaxis beyond 3 months is likely necessary to prevent the late onset of CMV disease and to improve the graft survival in this high-risk group. Currently, our CMV prophylaxis protocol increased from 3 to 6 months for all AA recipients with D+/R- serostatus.

Recent studies support prolonged CMV prophylaxis (beyond 3 months) in high-risk patients (6, 18, 19). The IMPACT study compared outcomes in high-risk patients (D+/R-) by days of VGCV prophylaxis, 100 vs. 200 (6). Compared with the 100-day group, significantly fewer patients in the 200-day group developed CMV disease during the first year after transplant (16.1% vs. 36.8%, $P < 0.0001$). There was no statistical difference in either acute rejection (11% vs. 17.2%, $P=0.1$) or graft loss (1.9% vs. 1.8%, $P=0.9$) by prophylaxis group. The 2-year follow-up of the IMPACT cohort demonstrated that very few cases of CMV disease developed between 12 to 24 months, and it confirmed the reduced incidence of CMV disease during the first year in high-risk recipients (D+/R-) with 200 days of chemoprophylaxis (18) Luan et al. (19) assessed the outcome and cost-effectiveness of a 6-month VGCV prophylaxis vs. 3-month historical control in D+/R- kidney and/or pancreas recipients. In the 12 months after completion of prophylaxis, CMV disease occurred in 12.1% and 24.4% of patients in the 6-month and 3-month groups, respectively. The cost-effectiveness analysis also supported the 6-month CMV prophylaxis (19). Some studies suggest that even longer period of chemoprophylaxis (> 6 months) may be needed in the high-risk patients (20-22).

The 3-year cumulative incidence of CMV disease was 7% in our overall AA cohort and 16.9% in the high-risk D+/R- group, both lower than in previous studies (2, 9, 10, 19). We did not routinely screen for CMV infection after transplant. The captured cases might represent clinical CMV disease only, and some patients with asymptomatic CMV infection or viremia were likely missed. Also, our center did not consider AA ethnicity to be a immunologic risk factor. Only a small proportion of the study population (18.8%) was considered high immunologic risk and received induction therapy with the IL-2 receptor antagonist basiliximab. T-cell-depleting antibody was not used as an induction agent in our program. A number of reports have shown an association between T-cell-depleting antibody and CMV disease (9-12).

It is also well known that CMV infection can increase the risk of graft rejection; and treatment of rejection can increase the risk of developing CMV disease or infection (3-6). We did notice several cases of CMV disease that developed after treatment of acute rejection. Episodes of acute rejection also occurred, which were diagnosed in patients after successful treatment of CMV disease. In our center, only steroid-resistant and severe rejection were treated with ATG. We found that acute rejection was associated with CMV disease by univariate analysis. However, neither usage of ATG nor basiliximab by itself related to development of CMV disease.

Kuypers and colleagues (23) reported on the association between the incidence of CMV disease and maintenance immunosuppression. They identified that the combined use of tacrolimus, mycophenolic acid, and steroids was an independent risk factor for CMV disease in kidney transplant recipients (23). Two retrospective studies noted an association between the risk of CMV disease and mycophenolic acid use (24, 25). In our study, tacrolimus rather than cyclosporine use was a risk factor of CMV disease by univariate analysis. The relationship between mycophenolic acid and CMV disease was not analyzed, as the majority of our subjects received this immunosuppressant.

Positive CMV serology in the general population approaches 60% in persons 20 years or older, and its incidence increases with age (26). Owing to the shortage of organ donors, kidneys are being transplanted from elderly donors, the so-called expanded criteria donors (27, 28). We found that donor age >60 years was a risk for CMV disease by univariate analysis, and it was an independent risk factor by multivariate analysis. This finding is consistent with the RESITRA study, which also demonstrated older donor age as a risk for CMV disease (10). Others have reported a higher percentage of CMV seropositivity in older donors that led to re-infection or primary infection in both seropositive and seronegative recipients (29, 30). Considering both these findings, universal CMV prophylaxis in kidney transplant recipients from elderly donors might be beneficial. This issue certainly needs to be studied further, especially considering the fact that expanded criteria donor kidneys are increasingly used for transplant.

Though our study is limited by its retrospective design and the single-center data, to our knowledge, only one previous report on CMV disease in AA patients has been published (31). This study analyzed 80 AA patients with a mean follow-up of 22 months. It concluded that D+/R- serostatus was an independent risk of CMV disease, which our current larger study supports.

In conclusion, 3-month universal chemoprophylaxis did not effectively prevent the development of CMV disease in the high-risk (D+/R-) group of AA patients. The incidence of CMV disease remained higher in the D+/R- group than in any other D/R serostatus group without routine chemoprophylaxis. More importantly, D+/R- serostatus was associated with the worst long-term graft survival. Therefore, a prolonged course of CMV prophylaxis should be considered to further decrease the incidence of late onset of CMV disease, and this treatment may eventually improve the graft survival in AA patients with D+/R- serostatus.

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Fig. 1.

The death-censored graft survival by Kaplan-Meier analysis. A significant difference is seen in the 3-year graft survival among the 4 groups (96% in D-/R-, 94% in D-/R+, 75% in D+/R-, and 92% in the D+/R+ group, log $P=0.01$). D, donor cytomegalovirus (CMV) serostatus; R, recipient CMV serostatus.

Table 1

Demographics, immunosuppressive drugs and rejection events in patients with and without cytomegalovirus (CMV) disease

	CMV disease (n = 31)	No CMV disease (n = 417)	P-value
Age, years	41.9 ± 15.4	42.1 ± 15.5	NS
Sex (M/F)	20/11	240/176	NS
Dialysis duration (months)	51.5 ± 41.8	49.4 ± 40.5	NS
Dialysis model			NS
Peritoneal	5 (16.1%)	39 (9.3%)	
Hemodialysis	20 (64.5%)	328 (78.7%)	
Both	3 (9.7%)	15 (3.6%)	
None	3 (9.7%)	35 (8.4%)	
HLA mismatch			NS
0 - 1	1 (3.6%)	29 (7.8%)	
2 - 4	14 (50%)	177 (47.7%)	
5 - 6	13 (46.4%)	167 (44.5%)	
BMI (kg/m ²)	27.5 ± 6.9	26.8 ± 7.1	NS
Waiting time (months)	29.7 ± 15.4	31.2 ± 17.9	NS
Cold ischemia time (hours)	15.9 ± 6.1	16.8 ± 7.4	NS
Peak PRA (%)	17.7 ± 31.8	16.9 ± 29.7	NS
Peak PRA > 50%	3 (16.6%)	27 (15.7%)	NS
Living donor	5 (16.1%)	88 (21%)	NS
Deceased donor	26 (83.9%)	329 (79%)	NS
Immunosuppressives			
Basiliximab	6 (19.4%)	78 (18.7%)	NS
Tacrolimus	22 (71%)	251 (60.2%)	0.31
Cyclosporine	7 (22.6%)	146 (35%)	0.22
Mycophenolate	29 (93.5%)	379 (90.9%)	NS
Rapamune	3 (9.6%)	21 (5%)	NS
Prednisone	28 (90%)	400 (96%)	NS
Acute rejection	9 (29%)	79 (18.9%)	0.25
ATG	5 (16.1%)	29 (7%)	0.13

M/F, male/female; BMI, body mass index; PRA, panel-reactive antigen; NS, nonsignificant; ATG, anti-thymocyte globulin.

Table 2

Distribution of cytomegalovirus (CMV) disease according to donor (D) / recipient (R) CMV serostatus

	D+/R+ n=205	D+/R- n=59	D-/R+ n=143	D-/R- n=41
Year 1	11	6	7	1
Year 2	1	3	0	0
Year 3	1	1	0	0
Total (%)	13 (6.3%)	10 (16.9%)	7 (4.9%)	1 (2.4%)

$P=0.022$, Fisher's exact test for comparing incidences of CMV disease across the four groups.

Table 3

Univariate analysis of risk factors for cytomegalovirus disease

	OR	95% CI		P-value
D+/R+	1.58	0.19	12.77	NS
D+/R-	4.66	0.53	40.88	0.01
D-/R+	0.75	0.08	7.1	NS
Donor age > 60	5.7	1.05	30.77	0.04
Recipient age > 60	0.88	0.26	3.03	NS
Male recipient (vs. female)	1.33	0.62	2.85	NS
Tacrolimus (vs. cyclosporine)	3.27	1.11	9.64	0.03
Basiliximab	1.21	0.56	2.6	NS
ATG	2.14	0.46	9.95	NS
Dialysis duration, months (x+1 vs. x)	1.001	0.99	1.01	NS
HLA mismatch	1.1	0.85	1.42	NS
Acute rejection	2.82	1.14	6.98	0.02
Chronic allograft nephropathy	1.38	0.39	4.81	NS

OR, odds ratio; CI, confidence interval; D, donor CMV serostatus; R, recipient CMV serostatus; ATG, anti-thymocyte globulin; HLA, human leukocyte antigen; NS, nonsignificant.