Lipid Disturbances Before and After Renal Transplant

Effat Razeghi,[1] Mohammadreza Shafipour,[1] Haleh Ashraf,[2] Gholamreza Pourmand[1]

Abstract

Objectives: **Hyperlipidemia is a significant metabolic disorder that is commonly encountered in renal transplant recipients. This study was conducted to investigate lipid disturbances and define its pattern in kidney recipients.**

Materials and Methods: **The records of 103 patients who had undergone a renal transplant between the years of 2004 and 2005 were retrospectively investigated. The lipid profile of these patients including total cholesterol, low-density lipoproteins, high-density lipoproteins, and triglyceride levels before and within 2 years' follow-up after transplant was evaluated. The demographics of the patients, cause of the end-stage renal failure, along with their immunosuppressive regimens were also considered.**

Results: **The study group included 43 women (41.8%) and 60 men (58.2%) (mean age, 39.25 ± 13.9 y). After transplant, laboratory analyses yielded significantly increased levels of total cholesterol, low-density lipoproteins, triglyceride levels, and high-density lipoproteins despite statin therapy, and the most important predictor for developing hypercholesterolemia and hypertriglyceridemia—pre-existing dyslipidemia. The effects of the various drugs on lipid metabolism were not different. These effects seen on the lipid profiles also were independent of the patients' age, sex, and cause of end-stage renal failure.**

Conclusions: **Despite statin treatment, renal transplants in our subjects were associated with a characteristic pattern of lipid disturbance with raised total cholesterol, low-density lipoproteins, high-density lipoproteins, and a concomitant increase in triglycerides. A more-aggressive approach to managing posttransplant hypercholesterolemia is warranted, especially in patients with pre-existing dyslipidemia.**

Key words: *Renal transplant, Statins, Lipids*

Introduction

Deranged lipids and lipoprotein metabolism represent a compelling problem among renal transplant recipients that can affect graft and patient survival. These lipid disturbances in kidney recipients enhance development of atherogenesis and then postrenal transplant coronary artery disease, being the most-common cause of posttransplant morbidity and mortality among long-term renal transplant survivors.[1, 2] Acute graft rejection is another complication of hyperlipidemia; it can increase the risk of graft loss 2 fold.[3] Hyperlipidemia also may contribute to chronic allograft nephropathy.[4] Dyslipidemia occurs in 16% to 78% of renal transplant recipients, depending on the patient population and the time point after transplant when serum lipids are examined.[5-13] However, there is a paucity of literature concerning the prevalence and type of lipoprotein abnormality in renal transplant recipients from the Iranian subcontinent. In our center, we performed a retrospective study on the longitudinal evolution of hyperlipidemia to investigate its prevalence and associated risk factors.

From the [1]Urology Research Center, Sina Hospital, Medical Sciences/University of Tehran, Hassan-Abad Sq., and the Research and Development Center, Sina Hospital, Medical Sciences/University of Tehran, Hassan-Abad Sq., Tehran, Iran.

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Address reprint requests to: *Effat Razeghi, Urology Research Center, Sina Hospital, Medical Sciences/University of Tehran, Hassan-Abad Sq., Tehran, Iran*

Phone: *+98 21 66735017* ***Fax:*** *+98 21 66717449* ***E-mail:*** *effat162@yahoo.com*

Haleh Ashraf, Research and Development Center, Sina Hospital, Medical Sciences/University of Tehran, Tehran, Iran

Phone: *+98 911 1839831* ***Fax:*** *+98 21 66717449* ***E-mail:*** *ha_as_ta@yahoo.com*

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Materials and Methods

We reviewed the records of 103 patients who had undergone a kidney transplant between 2004 and 2005 at the Renal Transplant Unit of Sina Hospital in Tehran, Iran. Patient's demographic data, underlying renal disorder, duration, and mode of renal replacement therapy before transplant; antihypertensive, lipid-lowering, and immunosuppressive medications, along with their laboratory data including total cholesterol, triglycerides, low-density lipoproteins, high-density lipoproteins, serum creatinine, and fasting blood sugar were included for analyses. The main outcome variables included the serial change in the lipid profile, the prevalence of dyslipidemia despite statin therapy, and the risk factors associated with development of lipid abnormalities.

Of the patients, 66.9% had been treated for hypertension at some time during follow-up. Hypotensive medications used included beta blockers (48 patients), diuretics (38 patients), prazosin (18 patients), and diltiazem (3 patients). The immunosuppressive protocol was standard triple-drug therapy consisting of cyclosporine, prednisolone and mycophenolate mofetil (97 patients), and azathioprine (6 patients). Twenty-four recipients diagnosed with acute rejection were treated with methylprednisolone pulses. Of the patients, 91.3% had used antilipid agents (83 patients on statins and 11 patients statins and gemfibrozil simultaneously). This was a fixed dosage and did not change during the study for any subject (atorvastatin 20 mg ± gemfibrozil 300 mg twice daily).

Overnight fasting lipids had been studied before renal transplant (T_0) and repeated after renal transplant at 0-6, 6-12, 12-18, and 18-24 months (T_6, T_{12}, T_{18}, and T_{24}). Total cholesterol, triglyceride, and high-density lipoprotein levels were determined using enzymatic methods. Low-density lipoprotein cholesterol was calculated based on the Friedewald formula.[14]

The study protocol was approved by local ethics committees and was conducted in accordance with the Helsinki declaration.[15] Written, informed consent was obtained from all subjects.

Definitions

Body mass index was calculated by dividing the patient weight (in kilograms) by the height (in meters squared). Hypercholesterolemia was defined as total cholesterol ≥ 5.17 mmol/L (200 mg/dL) or low-density lipoproteins ≥ 2.59 mmol/L (100 mg/dL), and hypertriglyceridemia as triglycerides ≥ 1.7 mmol/L (150 mg/dL).[16] A low, high-density lipoprotein was defined on values < 1.03 mmol/L for men (40 mg/dL) and 1.29 mmol/L for women (50 mg/dL). We also used 2 lipid ratios that have been shown to be predictors of adverse cardiovascular outcome in adults[16]: The low-density lipoprotein/high-density lipoprotein ratio (abnormal > 3.0) and the total cholesterol/high-density lipoprotein ratio (abnormal > 4.0).

Stastical Analyses

Statistical analyses were performed with SPSS software for Windows (Statistical Product and Service Solutions, version 15.0, SSPS Inc, Chicago, IL, USA). We used the chi-square test or Fisher exact test for proportions and paired-sample *t* test for parametric continuous variables, or the Wilcoxon rank sum tests for nonparametric values. Relations between variables were investigated by correlation, Pearson test for parametric, and the Spearman rank test for nonparametric parameters. Stepwise linear regression analysis was used to find the influence of recipient's age, sex, body mass index, baseline lipid profile, duration of dialysis, graft sufficiency (considered as creatinine level), whether a patient was hypertensive or diabetic, and use of various drugs on posttransplant lipid parameters. Variables are expressed as means with standard deviation or numbers (percentages). Statistical significance was set at a *P* value of < .05.

Results

The subjects consisted of 103 consecutive renal allograft recipients (60 men and 43 women; mean age, 39.25 ± 13.9 y at the time of transplant). Chronic renal failure with unknown cause and hypertension were the most-frequent underlying renal diseases, followed by diabetic nephropathy and polycystic kidney disease (Figure 1).

Serum lipoprotein profiles in kidney transplanted patients before and after transplant are shown in Figure 2. Despite statin therapy, in more than 90% of patients, after transplant, patients displayed a significant increase of triglycerides, total cholesterol, low-density lipoproteins, and high-density

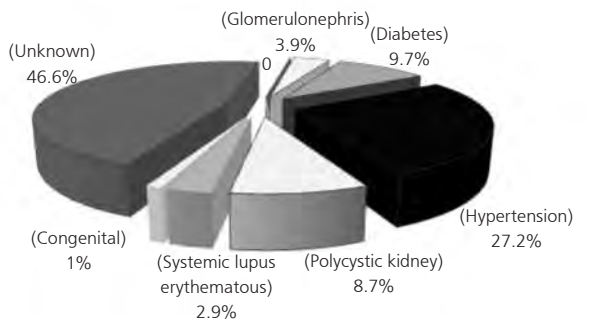

Figure 1. Cause of chronic kidney disease in study subjects.

lipoproteins. Values of triglycerides increased in the first year and total cholesterol, similar to low-density lipoproteins and high-density lipoproteins increased during the first 6 months after transplant, and fluctuated during the entire time, but in every month they remained considerably higher compared to baseline levels (Figure 2). The only exception was serum high-density lipoproteins and triglycerides between $T_{18\text{-}24}$, which were not significantly different compared with the pretransplant values. Lipid fluctuations had no influence on the low-density lipoproteins/high-density lipoproteins or total cholesterol/high-density lipoprotein ratios. Patients with cholesterol levels below 5.17 mmol/L before transplant exhibited significantly lower levels during the first 6 months after transplant than those with cholesterol levels ≥ 5.17 mmol/L before transplant ($P < .00001$).

The prevalence of hypercholesterolemia defined as *total cholesterol ≥ 5.17 mmol/L or low-density lipoproteins ≥ 2.59 mmol*; and was 12.6% and 23.3% in patients of end-stage renal disease and after renal transplant. This increased to 39.8%, 35.6%, 30.6%, and 36.7%; and 52.4%, 44.6%, 41.9%, and 40.8% at T_6, T_{12}, T_{18}, and T_{24}. The prevalence of hypertriglyceridemia at baseline and T_6, T_{12}, T_{18}, and T_{24} was 42.7%, 68.9%, 73.3%, 56.5%, and 46.9%. Apart from the frequency at T_{24}, these serial changes were

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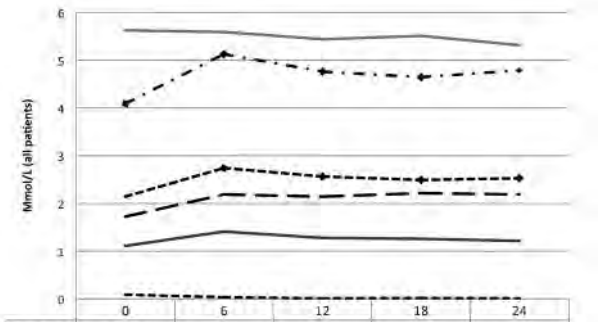

	0	6	12	18	24
TC	4,09	5,13	4,76	4,64	4,79
TG	1,72	2,19	2,14	2,21	2,19
LDL	2,14	2,74	2,56	2,49	2,53
HDL	1,11	1,41	1,28	1,26	1,21
FBS	5,63	5,59	5,44	5,51	5,31
cr	0,09	0,03	0,01	0,02	0,01
TC	4,09	5,13	4,76	4,64	4,79
TG	1,72	2,19	2,14	2,21	2,19
LDL	2,14	2,74	2,56	2,49	2,53
HDL	1,11	1,41	1,28	1,26	1,21
FBS	5,63	5,59	5,44	5,51	5,31
cr	0,09	0,03	0,01	0,02	0,01

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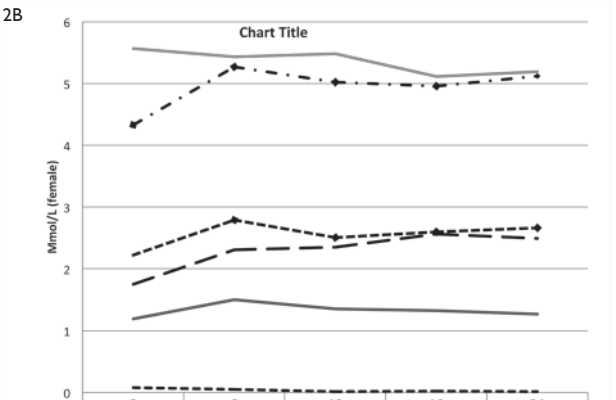

	0	6	12	18	24
TC	4,33	5,27	5,02	4,96	5,12
TG	1,75	2,31	2,35	2,56	2,49
LDL	2,22	2,79	2,51	2,6	2,66
HDL	1,19	1,5	1,35	1,32	1,27
FBS	5,57	5,43	5,48	5,11	5,19
cr	0,08	0,05	0,01	0,02	0,01

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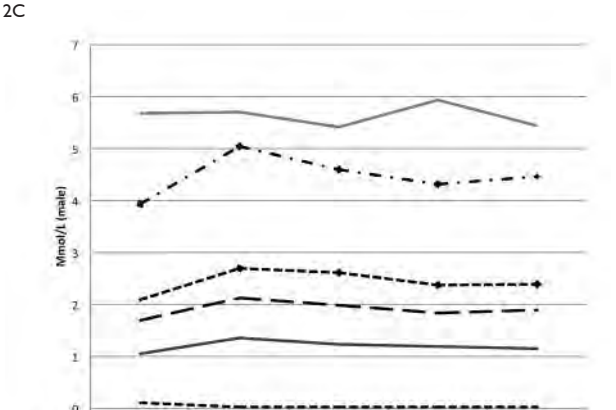

	0	6	12	18	24
TC	3,93	5,04	4,59	4,31	4,46
TG	1,69	2,12	1,98	1,83	1,89
LDL	2,09	2,69	2,61	2,37	2,39
HDL	1,05	1,35	1,23	1,19	1,15
FBS	5,68	5,7	5,41	5,93	5,44
cr	0,11	0,02	0,02	0,02	0,02

Figure 2. Trends in biochemical parameters in kidney recipient patients during the first 2-year period after Tx [all data are expressed as mean].
T_0, T_6, T_{12}, T_{18}, and T_{24} refer to times of lab studies before renal Tx and repeated after renal Tx at 0-6, 6-12, 12-18, and18-24 months.
Abbreviations: Cr, creatinine; FBS, fasting blood sugar; HDL, high-density lipoprotein cholesterol; LDL, low-density lipoprotein cholesterol; TC, total cholesterol; TG, triglycerides.

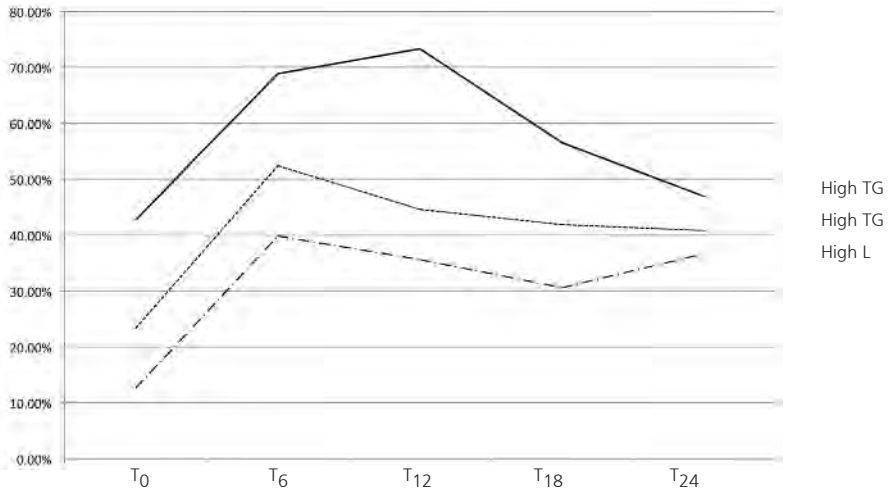

Figure 3. Frequency of hypercholesterolemia and hypertriglyceridemia in kidney recepients before Tx and in 2- year follow-up. T_0, T_6, T_{12}, T_{18}, and T_{24} refer to times of lab studies before renal Tx and repeated after renal Tx at 0-6, 6-12, 12-18, and18-24 months.
Abbreviations: LDL, low-density lipoprotein cholesterol; TC, total cholesterol; TG, triglycerides.

significantly different compared with baseline ($P < .05$ for each comparison). Figure 3 depicts the changes in frequency of hypercholesterolemia and hypertriglyceridemia during the study. There was a significant elevation in the mean values of serum triglycerides, serum cholesterol, and high-density lipoproteins in diabetics with end-stage renal disease ($P < .001$); however, after a renal transplant, the lipid profile in both groups was not significantly different ($P > .05$). Fetal bovine serum values failed to show any significant modification following engraftment ($P > .05$).

Tables 1 and 2 depict the variables that significantly and independently affected the risk of development of dyslipidemia for each of the lipid values. All patients studied showed a close correlation between pretransplant and posttransplant lipid levels (Table 1). In a multiple linear regression model, posttransplant total cholesterol and low-density lipoprotein levels significantly correlated with per transplant total cholesterol values. In addition, factors that were better predictors of high-density lipoprotein-level were baseline high-density lipoproteins and higher body mass index at time of transplant; for triglycerides, they were pretransplant values of triglyceride levels (Table 2). The duration of dialysis, diabetes, or hypertension status, serum creatinine before transplant and at 1 year, and the use of beta-blockers or diuretics were not associated with development of posttransplant dyslipidemia.

Table 1. Correlation between pretransplant and posttransplant (within first 6 months) values of lipid parameters tested.

	r	*P* value
Triglycerides	0.329	.001
Total cholesterol	0.358	< .00001
Low-density lipoprotein cholesterol	0.263	.007
High-density lipoprotein cholesterol	0.277	.005

Table 2. Multivariable logistic regression analysis for predictors of dyslipidemia.

Response	Parameter	Standardized ß	*P* value
Triglycerides	Baseline triglycerides	0.245	.008
Total cholesterol	Baseline total cholesterol	0.28	.003
Low-density lipoprotein cholesterol	Baseline total cholesterol	0.305	.001
High-density lipoprotein cholesterol	Baseline HDL	0.259	-0.260
	Body mass index	.006	.006

Discussion

Patients who undergo a renal transplant often have end-stage renal disease for years, and many of them already have lipid derangement before transplant.[10] It has been reported that lipid metabolism is not normalized by recovery of renal function after kidney transplant,[13] as hyperlipidemia is common despite statin therapy, particularly within the first year after transplant (with increases noted for total cholesterol, low-density lipoproteins, triglycerides, and high-density lipoproteins). In the first 6 months after transplant, total cholesterol increased by 27.2%, and, accordingly, low-density lipoproteins increased by 29.1%, and high-density lipoproteins increased by 26.2%, as compared to pretransplant levels.

Data from cross-sectional and longitudinal studies on posttransplant lipid disturbances have demonstrated that hyperlipidemia affected 16% to 78% of renal allograft recipients[5-13] in different

communities, depending at which time point posttransplant serum lipid levels are obtained. Variations in the diagnostic criteria, duration of renal failure, diet, different proportions of patients on lipid-lowering treatment, and the genetic and ethnic predisposition also could account for this difference and variation in the severity and/or pattern of hyperlipidemia after kidney transplant. The causes of hyperlipidemia include increased nutrient intake after transplant and adverse effects of steroid or cyclosporine used as immunosuppression. However, the mechanisms have not been completely elucidated.[3, 10]

There have been relatively little data on hyperlipidemia among Middle East kidney allograft recipients. In a previous series from Iran[18], 59.9% of patients had total cholesterol > 200, and 73% had high triglycerides, using a cutoff of 120 for men and 170 in women at a duration of 1 to 12 months after kidney transplant. However, details on the allograft function and lipid-lowering treatment and other components of the lipid profile and other serum lipoproteins, such as high-density lipoproteins and low-density lipoproteins, were missed. In another series of 1096 stable kidney recipients from Saudi Arabia, the prevalence of moderate (total cholesterol 6.1-8 mmol/L) or severe hypercholesterolemia (total cholesterol > 8.0 mmol/L) were 33.1% and 5.2%, at 66.9 months after kidney transplant, with body weight, age, diabetes, and retransplants being significant predictors of hyperlipidemia.[18]

In our patients, the prevalence of hypercholesterolemia peaked within the first 6 months, affecting 40% to 50% of patients, whereas the peak increases of hypertriglyceridemia occurred later, at 12 months after transplant. This observation is also in accordance with other studies.[6, 19]

The increase of high-density lipoproteins directly after transplant could be associated with an overproduction of this fraction and with elimination of uremic toxins by the transplanted kidney and also, chronic administration of corticosteroids.[20] Several investigators have indicated that the observed increase in high-density lipoprotein levels in kidney recipients is not associated with a corresponding protection against complications of atherogenic processes.[20, 21] This phenomenon remains to be elucidated, but it could be connected to changes of high-density lipoprotein molecular quality and decrease of anti atherosclerotic high-density lipoprotein[2] fraction, and also, intensive low-density lipoprotein oxidation.[22]

Although previous studies have focused mainly on the elevation of serum cholesterol, our data underscore the progressive increase in triglycerides after renal transplant. The role of hypertriglyceridemia in the development of the vascular atherogenic process has not been explained. Hypertriglyceridemia predisposes one to form small, thick, low-density lipoprotein molecules, which undergo oxidation process easier and circulate longer in plasma, because of lower affinity to low-density lipoprotein receptor.[23] This mechanism could potentially explain the higher incidence of cardiovascular disease in this group of patients.

Although our results are in accord with other studies,[10, 12, 13] they show a tendency toward amelioration of the prevalence and severity of dyslipidemia over time (Table 1 and Figure 2); only slight, nonsignificant decreases of total cholesterol and low-density lipoprotein levels in the second year after transplant were observed, and mean lipid levels at the end of follow-up were higher than baseline. In our study, 68.6% of our subjects had triglyceride levels exceeding 200 mg/dL initially, but only 46.9% of them at the end of follow-up. The notion regarding transient hypertriglyceridemia only in the first year after transplant admitted in some studies[19]; however, this view has been questioned by others.[1, 24]

In line with published results,[25] data from this series also suggest that the most-important predictor for developing hypercholesterolemia and hypertriglyceridemia is pre-existing dyslipidemia; that is, patients who had dyslipidemia before the transplant had a higher risk of being so after the transplant. All of our patients showed a close correlation between pretransplant and posttransplant lipid levels, which point to the existence of host factors (environmental or genetic predisposition) that play a significant role in determining lipid levels.[26] Other contributing factors of posttransplant hyperlipidemia (none operable in our study) include sex, weight gain, body fat increment, improved appetite, reduced creatinine clearance, ischemic heart disease, high fasting glucose at 1 year, proteinuria, posttransplant follow-up duration, atherogenic immunosuppressive drugs, steroid dosage, lack of exercise, smoking, diabetes, and concomitant use of diuretics or beta blockers.[5-13, 25, 26] The relative contribution of these factors to the genesis of posttransplant hyperlipidemia is unclear.

It is worth mentioning that the age of our recipients did not have any influence on the lipid profile in kidney recipients, which means that young patients face the same risk of atherogenic complications as do older patients.

Additionally, the increasing incidence of hypercholesterolemia and hypertriglyceridemia is correlated with posttransplant weight gain as a key factor of cardiovascular disease and decreased survival after renal transplant.[27-29] A better understanding of the various factors involved in these changes in lipoprotein metabolism will probably help decrease the incidence of cardiovascular complications of kidney transplant recipients.

In conclusion, renal transplant in our subjects, despite statin treatment, is associated with a characteristic pattern of lipid disturbance with raised total cholesterol, low-density lipoproteins, high-density lipoproteins, and concomitant increase in triglycerides. We used low-dose antilipid therapy in our patients, but a more-aggressive approach with close monitoring for myopathy and liver function for managing posttransplant hypercholesterolemia may be warranted, especially in patients with pre-existing dyslipidemia before transplant.

References

1. Markell MS, Friedman EA. Hyperlipidemia after organ transplantation. *Am J Med.* 1989;87(5N):61N-67N.
2. Bumgardner GL, Wilson GA, Tso PL, et al. Impact of serum lipids on long-term graft and patient survival after renal transplantation. *Transplantation*. 1995;60(12):1418-1421.
3. Stephan A, Barbari A, Karam A, Kilani H, Kamel G, Masri A. Hyperlipidemia and graft loss. *Transplant Proc.* 2002;34(6):2423-2425.
4. Cohen D, Galbraith C. General health management and long-term care of the renal transplant recipient. *Am J Kidney Dis*. 2001;38(6 suppl 6):S10-S24.
5. Knight RJ, Vathsala A, Schoenberg L, et al. Treatment of hyperlipidemia in renal transplant patients with gemfibrozil and dietary modification. *Transplantation.* 1992;53(1):224-225.
6. Baliga Lt Col KV, Sharma Maj PK, Prakash Lt Col MS, Mostafi Maj M. Lipid profile in transplant patients: A clinical study. *MJAFI*. 2002;58:32-35
7. Ishii T, Imanishi M, Nishioka T, Kunikata S, Akiyama T, Kurita T. Changes in serum lipid and (APO) lipoprotein levels in renal transplant recipients. *Transplant Proc.* 1998;30(7):3021-3022.
8. Kisielnicka E, Zdrojewski Z, Wróblewska M, Kortas B, Rutkowski B. Lipid disturbances in a two-year follow-up after successful kidney transplantation. *Transplant Proc.* 2000;32(6):1358-1362.
9. Ong-Ajyooth L, Sirisalee K, Shayakul C, et al. Hyperlipidemia in stable renal transplant recipients. *Transplant Proc.* 1994;26(4):2062-2064.
10. Pannu HS, Singh D, Sandhu JS. Lipid profile before and after renal transplantation–a longitudinal study. *Ren Fail*. 2003;25(3):411-417.
11. Schena A, Di Paolo S, Morrone LF, Resta F, Stallone G, Schena FP. Are lipid-dependent indicators of cardiovascular risk affected by renal transplantation? *Clin Transplant*. 2000;14(2):139-146.
12. Shaheen FA, Souqiyyeh MZ, Shiek IA, et al. Hypercholesterolemia in renal transplantation. *Ann Transplant*. 2001;6(4):9-13.
13. Tse KC, Lam MF, Yip PS, Li FK, Lai KN, Chan TM. A long-term study on hyperlipidemia in stable renal transplant recipients. *Clin Transplant*. 2004;18(3):274-280.
14. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clin Chem*. 1972;18(6):499-502.
15. Ethics Unit. Declaration of Helsinki. World Medical Association Web site. http://www.wma.net/e/ethicsunit/helsinki.htm. Accessed June 11, 2011.
16. Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, And Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III). *JAMA*. 2001;285(19):2486-2497.
17. Martins L, Ventura A, Costa S, Henriques A, Dias L, Sarmento A. Long-term complications after renal transplantation. *Transplant Proc*. 2003;35(3):1083-1084.
18. Ramezani M, Einollahi B, Ahmadzad-Asl M, et al. Hyperlipidemia after renal transplantation and its relation to graft and patient survival. *Transplant Proc.* 2007;39(4):1044-1047.
19. Vathsala A, Weinberg RB, Schoenberg L, et al. Lipid abnormalities in cyclosporine-prednisone-treated renal transplant recipients. *Transplantation.* 1989;48(1):37-43.
20. Kobayashi N, Okubo M, Marumo F, Uchida H, Endo T, Nakamura H. De novo development of hypercholesterolemia and elevated high-density lipoprotein cholesterol: apoprotein A-I ratio in patients with chronic renal failure following kidney transplantation. *Nephron*. 1983;35(4):237-240.
21. Drüeke TB, Abdulmassih Z, Lacour B, Bader C, Chevalier A, Kreis H. Atherosclerosis and lipid disorders after renal transplantation. *Kidney Int Suppl.* 1991;31:S24-8.
22. Ettinger WH, Bender WL, Goldberg AP, Hazzard WR. Lipoprotein lipid abnormalities in healthy renal transplant recipients: persistence of low HDL2 cholesterol. *Nephron*. 1987;47(1):17-21.
23. Tribble DL. Lipoprotein oxidation in dyslipidemia: insights into general mechanisms affecting lipoprotein oxidative behavior. *Curr Opin Lipidol.* 1995;6(4):196-208.
24. Cassader M, Ruiu G, Gambino R, Alemanno N, Triolo G, Pagano G. Lipoprotein-apolipoprotein changes in renal transplant recipients: a 2-year follow-up. *Metabolism*. 1991;40(9):922-925.
25. Butani L. Prospective monitoring of lipid profiles in children receiving pravastatin preemptively after renal transplantation. *Pediatr Transplant*. 2005;9(6):746-753.
26. Markell MS, Armenti V, Danovitch G, Sumrani N. Hyperlipidemia and glucose intolerance in the post-renal transplant patient. *J Am Soc Nephrol.* 1994;4(suppl 8):S37-S47.
27. Dumler F, Kilates C. Metabolic and nutritional complications of renal transplantation. *J Ren Nutr*. 2007;17(1):97-102.
28. Kent PS. Issues of obesity in kidney transplantation. *J Ren Nutr*. 2007;17(2):107-113.
29. Nazemian F, Naghibi M. Weight-gain-related factors in renal transplantation. *Exp Clin Transplant*. 2005;3(1):329-332.