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Original Research Article

A Comparative Study of the Efficacy and Safety of Rosuvastatin versus Atorvastatin in Patients of Type 2 Diabetes Mellitus with Dyslipidemia

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Abstract:

Background: Cardiovascular disease (CVD), which is strongly connected with diabetes dyslipidemia, is responsible for over 80% of deaths in diabetic individuals. When treating dyslipidemia with elevated LDL-C, statins are the preferred medication. In order to inform current care methods for type 2 diabetes mellitus in the Indian population, this study analyzes the efficacy and safety of rosuvastatin to the widely used atorvastatin in patients with dyslipidemia.

Methods: The study was a single blinded study conducted in JNKTMCH, Madhepura, Bihar from November 2022 to April 2023. Patients who met the requirements for participation were divided into two groups randomly. Atorvastatin (10 mg) was given to group I, and rosuvastatin (5 mg) was given to group II, orally each night before bed. On weeks 0, 6, and 12, serum TC, LDL-C, HDL-C, and TG levels were measured.

Results: At the end of the 12-week period, the atorvastatin group's percentage reduction in LDL-C levels was 33.58%, whereas the rosuvastatin group's percentage reduction was 43.12%. Total cholesterol (TC) decreased by 24.85% in the atorvastatin group and by 30.8% in the rosuvastatin group. The increase in HDL-C levels was 7.1% in the atorvastatin group and 11.16% in the rosuvastatin group. These variations were statistically significant in all cases. Between the two groups, there was no discernible difference in the reduction of TG levels.

Conclusions: When compared to atorvastatin 10mg therapy, rosuvastatin 5mg induces higher reductions in LDL-C and TC, equivalent reductions in TG, and a greater rise in HDL-C.

Keywords: Atorvastatin, Cholesterol, Cardiovascular disease, Diabetes, Dyslipidemia, Rosuvastatin.

Introduction

A common metabolic condition called diabetes mellitus is defined by absolute or relative deficits in insulin secretion and/or action along with persistent hyperglycemia and changes in protein, lipid, and carbohydrate metabolism.[1] The distinction of being referred to as the world's diabetic capital has been achieved by India.[2] In India, 69.2 million persons between the ages of 20 and 79 are thought to have diabetes. By 2040, this figure is projected to rise to 123.5 million. In India in 2015, almost 1 million people lost their lives to diabetes.[3] Due to hyperglycemia, diabetes mellitus is linked to increased oxidative stress, which contributes to the development of micro and macro vascular problems affecting nearly all vital organs, including the heart, eyes, kidneys, blood vessels, and neurological system. These issues cause the emergence of insulin resistance, obesity, hypertension, and dyslipidemia.[4] Cardiovascular disease (CVD), which is strongly connected with diabetes dyslipidemia, is responsible for over 80% of deaths in diabetic individuals.[5] A pro-atherogenic lipid profile is one with small, dense Low Density Lipoprotein (LDL) particles, low levels of High Density Lipoprotein (HDL), and high levels of triglycerides (TG) as a result of abnormalities in the lipid profile that cause the release of free fatty acids from adipose tissue, increased delivery of these acids to the liver, and increased hepatic synthesis of lipoproteins.[6,7] Patients with T2DM have an early onset of aberrant endothelial dysfunction, platelet hyperactivity, and impaired fibrinolysis with a tendency for thrombosis and inflammation in addition to the co-existence of cardiovascular risk factors and co-morbidity. This causes severe atherosclerosis and unfavorable vascular remodeling to develop early.[8] The primary path gnomic mechanism for CVD is atherosclerosis of the coronary veins, and efforts to minimize this represent an essential

treatment option to lower mortality associated with acute cardiovascular events.[9] Therefore, the initial step in treating diabetic dyslipidemia is to lower LDL-C levels.

The enzyme 3-hydroxy-3-methyl glutaryl coenzyme A (HMG-CoA) reductase, which catalyzes an early, rate-limiting step in cholesterol production, is competitively inhibited by statins.[10] These cholesterol lowering medications are now the first choice for treating dyslipidemia caused by elevated LDL-C because of their safety, effectiveness, and tolerability.[11] Statins dramatically lower vascular events and all-cause mortality through their pleiotropic effects, in addition to the numerical reduction in lipid levels. Statins have already been shown to have antioxidant, anti-inflammatory, and antithrombotic actions, all of which increase their clinical usefulness.[12] They enhance endothelial dysfunction and stop atherosclerotic plaque from expanding.[13] To get the same LDL-C level, different statins must be dosed differently.[14] The effectiveness and safety of atorvastatin and rosuvastatin in lowering fatal and non-fatal CVD events have been demonstrated in numerous clinical trials.The statin that is most frequently prescribed is atorvastatin.[11] Research from Western nations indicates that rosuvastatin results in larger LDL-C reductions.[16]

It is generally recognized that Asians may react differently from Whites due to genetic differences in drug metabolism at the level of hepatic enzymes and drug transporters, but such data from our nation in the clinical subset of diabetes patients is sparse.[17] In order to inform current care methods for type 2 diabetes mellitus in the Indian population, the present study was designed to compare the efficacy and safety of rosuvastatin to the frequently used atorvastatin in patients with dyslipidemia.

Material and Methods

This study was conducted at Pharmacology department with association of Medicine of Jannayak Karpoori Thakur Medical College and Hospital, Madhepura, Bihar from November 2022 to April 2023.

The medical OPD was used to find the patients. They underwent screening in order to take part in the study. Patients were diagnosed based on their medical history and results of biochemical tests. The study's aims and objectives were thoroughly conveyed to patients who were deemed suitable for inclusion. They were made aware of both the advantages and potential drawbacks of the study. They provided written informed permission after being told of the full scope of the investigation. The sample informed consent paper served as the foundation for the written consent. Using the chit method, the patients were randomly assigned to either group I or group II of the treatment group. Patients received the medicine while being blinded and kept in the dark. At the time of the patient's enrollment (0 week), baseline tests were performed, including those for blood TC, serum LDL-C, serum HDL-C, serum TG levels, SGOT, SGPT, and serum creatine phosphokinase (CPK) levels.

Atorvastatin (10 mg) was given orally to patients in Group I at bedtime every day, while rosuvastatin (5 mg) was given orally to patients in Group II at bedtime every day. All patients also took any additional medications that were prescribed at the same time, such as anti-diabetic, anti-hypertensive, or anti-anginal medications, per the doctor's advice. No patient utilized niacin, bile acid sequestrants, fibrates, or any other lipid-lowering medications. Patients who were already receiving statin medication were permitted a six-week drug wash-out time.

The study's 12-week treatment period began on the day of randomization. Following randomization, follow-up appointments were set for 6 and 12 weeks. At each check-up, measurements of the blood TC, LDL-C, HDL-C, and TG were estimated, and patients were also questioned and checked for the presence of myalgia, jaundice, or any other negative effects. Additionally, CPK, SGOT, and SGPT estimations were performed in all patients from both groups at 6 and 12 weeks to look for myopathy or hepatotoxicity. The 'Z' test, paired t-test, and unpaired t-test were used appropriately in the statistical analysis. Statistical significance was defined as a 'p' value <0.05.[18]

Results

100 patients in all were involved in the study, 50 of whom were divided into daily atorvastatin and daily rosuvastatin groups. Two patients from the daily atorvastatin group and one patient from the daily rosuvastatin group were lost to follow-up throughout the research period and were therefore omitted from the analysis.

Thus, for the purpose of data analysis, 48 patients from the daily atorvastatin group and 49 patients from the daily rosuvastatin group were taken into account. Regarding age, sex, and clinical profile, the baseline characteristics of the patients in both groups were equivalent.

Table 1: Baseline lipid profile of patients

Baseline lipid values (mg/dl)	Daily Atorvastatin (10mg) Mean ± S.D.	Daily Rosuvastatin (5mg) Mean ± S.D.	p-value
Low density lipoprotein cholesterol (LDL-C)	154.4±13.65	153.1±15.45	>0.05
Total cholesterol (TC)	225.68±15.58	224.66±16.04	>0.05
Triglyceride (TG)	155.04±22.25	154.82±26.17	>0.05
High density lipoprotein cholesterol (HDL-C)	40.27±3.58	40.59±3.18	>0.05

As shown in Table 1, there was no statistically significant difference between the two groups (p>0.05) in their baseline mean lipid values.

Table 2: LDL-C (mg/dl) in both treatment groups

Group	Daily Atorvastatin (10mg) Mean ± S.D.	Daily Rosuvastatin (5mg) Mean ± S.D.	p-value
6 weeks	121.83±19	106.39±13.04	<0.0001
12 weeks	102.56±16.11	87.1±11.68	<0.0001

As shown in Table 2, patients receiving rosuvastatin therapy experienced a considerably higher decrease in LDL-C values than patients receiving atorvastatin therapy (p<0.0001). At 6 and 12 weeks, the atorvastatin group's LDL-C levels had decreased by 21.1% and 33.58%, respectively. At 6 and 12 weeks, the rosuvastatin group's LDL-C values had decreased by 30.51% and 43.12%, respectively.

Table 3: Percentage of patients who achieved levels of LDL-C <100 mg/dL

Group	Daily Atorvastatin (10mg)	Daily Rosuvastatin (5mg)	p-value
6 weeks	20.83% (10/48)	44.9% (22/49)	<0.05
12 weeks	60.42% (29/48)	83.67% (41/49)	<0.05

As shown in Table 3, a significantly greater proportion of patients in the rosuvastatin group attained LDL-C values below 100 mg/dL at 6 and 12 weeks (p<0.05).

Table 4: Levels of total cholesterol (TC) mg/dL in two treatment groups

Group	Daily Atorvastatin (10mg) Mean ± S.D.	Daily Rosuvastatin (5mg) Mean ± S.D.	p-value
6 weeks	190.22±20.02	174.4±14.16	<0.0001
12 weeks	169.59±18.04	155.47±13.77	<0.0001

The reduction in total cholesterol levels in the rosuvastatin group was substantially greater than in the atorvastatin group, as shown in Table 4 (p<0.0001). At 6 and 12 weeks, the atorvastatin group's total cholesterol decreased by 15.71% and 24.85%, respectively. At 6 and 12 weeks, the overall cholesterol reduction in the rosuvastatin group was 22.37% and 30.8%, respectively.

Table 5: Triglyceride (TG) mg/dL in two treatment groups

Group	Daily Atorvastatin (10mg) Mean ± S.D.	Daily Rosuvastatin (5mg) Mean ± S.D.	p-value
6 weeks	130.67±18.14	126.27±23.11	>0.05
12 weeks	119.50±18.07	116.24±22.71	>0.05

As shown in Table 5, despite the fact that patients receiving rosuvastatin therapy had lower levels of triglycerides than patients receiving atorvastatin medication, the difference was not statistically significant (p>0.05). At 6 and 12 weeks, the atorvastatin group's triglyceride levels had decreased by 15.72% and 22.92%, respectively. At 6 and 12 weeks, the rosuvastatin group's triglyceride levels decreased by 18.44% and 24.92%, respectively.

Table 6: Changes in mean values of HDL-C (mg/dL) in two treatment groups

Group	Daily Atorvastatin (10mg) Mean ± S.D.	Daily Rosuvastatin (5mg) Mean ± S.D.	p-value
6 weeks	42.25±3.46	42.76±3.16	>0.05
12 weeks	43.13±3.67	45.12±3.33	<0.05

As shown in Table 6, the difference between the two treatments was not statistically significant at 6 weeks (p>0.05), but at 12 weeks, rosuvastatin medication significantly increased HDL-C levels compared to atorvastatin therapy (p<0.05).

There were a total of 7 individuals on atorvastatin and 9 patients taking rosuvastatin who experienced minor, self-limiting side effects such nausea, headaches, body aches, and abdominal pain. Between the two treatment groups, there was no statistically significant difference in the frequency of these side events ($p>0.05$). No subject experienced any major adverse events throughout the course of the research. At the end of the 12-week trial period, neither group of patients had any serum CPK, SGOT, or SGPT levels that had significantly increased.

Discussion

Patients in the current trial were treated daily with either atorvastatin (10 mg) or rosuvastatin (5 mg). In numerous trials comparing the effectiveness and safety of atorvastatin medication with that of rosuvastatin, comparable doses had been employed. Adsule et al, Barakat et al, URANUS, andROMEDA, among other trials, all employed 10 mg of atorvastatin.[19-22] Ten milligrams of atorvastatin were compared against five milligrams of rosuvastatin in the LISTEN study and the Arshad et al. trial.[23,24] Additionally, Asians should begin taking rosuvastatin at a dose of 5 mg, whereas atorvastatin should be started at a dose of 10 mg.[25,26]

It was discovered in the current study that there was a statistically significant difference between atorvastatin and rosuvastatin medication in the lowering of LDL-C levels at the end of 12 weeks. Additionally, the rosuvastatin group's percentage reduction in LDL-C levels was noticeably larger. These results are in line with those of the ANDROMEDA, URANUS, CORALL, and LISTEN studies, which all involved diabetic individuals with dyslipidemia.[20,19,27,23]

In the double-blind ANDROMEDA research, rosuvastatin (10 mg) had a 51% reduction in LDL-C levels from baseline at 8 weeks compared to the atorvastatin (10 mg) group's 39% drop.20 At the end of the 16-week study, the percentage reduction in LDL-C levels from baseline in the atorvastatin group was 45.5%, whereas it was 52.3% in the rosuvastatin group in the URANUS study, which compared atorvastatin and rosuvastatin. Both medications were started at 10 mg per day, and the dose was increased on a periodic basis until specific LDL-C goals were achieved.[19] Similar outcomes were found in the CORALL research, where, after 12 weeks, the LDL-C levels in the atorvastatin 20 mg and rosuvastatin 10 mg groups, respectively, had decreased by 45.6% and 50.6%, respectively.[27] In these investigations, there was a statistically significant difference between the groups receiving atorvastatin and rosuvastatin in terms of the percentage reductions of LDL-C values.[19,20,27] When comparing the overall findings at the end of 3, 6, and 12 months in the LISTEN study, the rosuvastatin group also demonstrated larger % reductions in LDL-C levels compared to the atorvastatin group.[23]

Rosuvastatin dramatically reduced LDL-C levels more than its rivals, according to the STELLAR study, which also included non-diabetics and compared it to atorvastatin, simvastatin, and pravastatin.[28] These conclusions mirror those of the current study. Although the percentage reduction in LDL-C was higher in the rosuvastatin group (44.25%) than in the atorvastatin group (35.56%) in the prospective, randomized study by Adsule et al., this difference was not statistically significant ($p>0.05$), which may be related to the smaller sample size.[21]

In the current trial, considerably more individuals in the rosuvastatin group had LDL-C values below 100 mg/dL after 12 weeks (Table 3). Similar results were found in the CORALL research, where 83.1% of patients on rosuvastatin and 76.5% of patients using atorvastatin both had LDL-C values below 100 mg/dL at the end of the 12-week period.[27] In the current study, the rosuvastatin group experienced a considerably larger percentage reduction in total cholesterol (TC) at the conclusion of the 12 week period. The URANUS experiment and the CORALL investigation both reported conclusions that were similar.[19,27]

However, despite rosuvastatin causing a bigger percentage reduction in TC than atorvastatin (30.83% vs. 25.75%), the study by Adsule et al. indicates that there was no statistically significant difference, which may be related to the smaller sample size.[21]

At the conclusion of the current trial, the atorvastatin and rosuvastatin groups both saw percentage reductions in triglyceride levels of 22.92% and 24.92%, respectively. However, this difference between the two groups was not statistically significant. The CORALL, URANUS, ANDROMEDA, and LISTEN trials, as well as the study by Adsule et al.[27,19,20,23,21], all revealed similar results.

In the current study, atorvastatin and rosuvastatin considerably raised HDL-C levels when compared to their respective baseline levels after 6 weeks and 12 weeks of medication, however the difference between the two groups after 6 weeks was not statistically significant. However, rosuvastatin generated a statistically significant increase in HDL-C compared to atorvastatin at the conclusion of the 12-week period (11.16% vs. 7.1%). This outcome is consistent with research on Asian diabetic dylipidemic patients. Similar findings were obtained from the LISTEN and ASTRO-2 trials on Japanese patients as well as the Adsule et al.

investigation on Indian individuals.[23,29,21] European investigations on diabetics with dyslipidemia, such as CORALL, URANUS, and ANDROMEDA, however, found no statistically significant differences between the atorvastatin and rosuvastatin groups despite statistically substantial increases in HDL-C levels within those groups.[27,19,20] This may be explained by the fact that Asians have higher plasma exposure to rosuvastatin and its metabolites than Europeans do.[30,31]

Thus, when compared to atorvastatin 10mg medication, the results of our study show that treatment with rosuvastatin 5mg induces larger reduction in LDL-C and TC and comparable reduction in TG. At the conclusion of 12 weeks, rosuvastatin therapy also caused HDL-C levels to raise more than they did with atorvastatin therapy, with the inter-group difference being statistically significant.

The results of the current study suggest that rosuvastatin was successful in achieving a reduced atherogenic lipid profile when taking into account the overall alterations to lipid variables. Both regimens' safety and tolerability in the current trial were consistent with those seen in earlier research.[19,20-23,27]

Conclusion

In individuals with type 2 diabetes mellitus and dyslipidemia, rosuvastatin 5 mg is more effective than atorvastatin 10 mg in lowering LDL-C and TC levels and raising HDL-C levels. It also demonstrated a similar safety profile to atorvastatin 10 mg after 12 weeks of therapy. The increased effectiveness of rosuvastatin will make it possible for more patients to meet the specified treatment objectives in clinical practice and may further lower the risk of CVD. To evaluate whether rosuvastatin has the potential to be a more affordable treatment option than atorvastatin, however, long-term economic assessments of the drug are required.

References

1. Abou-Seif MA, Youssef AA. Evaluation of some biochemical changes in diabetic patients. Clin Chim Acta. 2004 Aug 16;346(2):161-70.
2. Mohan V, Sandeep S, Deepa R, Shah B, Varghese C. Epidemiology of type 2 diabetes: Indian scenario. Indian J Med Res. 2007 Mar 1;125(3):217.
3. International Diabetes Federation. IDF Diabetes Atlas, 7ed. Brussels, Belgium: International Diabetes Federation, 2015. Available from: http://www.diabetesatlas.org/component/attachment s/?task= downloadandid=116. Accessed 11 Nov. 2016.
4. O'Brien RC, Luo M, Balazs N, Mercuri J. In vitro and in vivo antioxidant properties of gliclazide. J Diabetes Complicat. 2000 Aug 31;14(4):201-6.
5. O'Keefe JH, Miles JM, Harris WH, Moe RM, McCallister BD. Improving the adverse cardiovascular prognosis of type 2 diabetes. Mayo Clin Proc. 1999 Feb;74(2):171-80.
6. Ginsberg HN. Diabetic dyslipidemia: basic mechanisms underlying the common hypertriglyceridemia and low HDL cholesterol levels. Diabetes. 1996 Jul 1;45(Supplement 3):S27-30.
7. Grundy SM. Hypertriglyceridemia, atherogenic dyslipidemia, and the metabolic syndrome. Am J Cardiol. 1998 Feb 26;81(4):18B-25B.
8. Beckman JA, Creager MA, Libby P. Diabetes and Atherosclerosis: Epidemiology, Pathophysiology, and Management. JAMA. 2002;287(19):2570-81.
9. Lloyd-Jones DM, O'Donnell CJ, D'Agostino RB, Massaro J, Silbershatz H, Wilson PW. Applicability of cholesterol-lowering primary prevention trials to a general population: the Framingham heart study. Arch Intern Med. 2001 Apr 9;161(7):949-54.
10. Cilla DD, Whitfield LR, Gibson DM, Sedman AJ, Posvar EL. Multiple-dose pharmacokinetics, pharmacodynamics, and safety of atorvastatin, an inhibitor of HMG-CoA reductase, in healthy subjects. Clin Pharmacol Ther. 1996;60(6):687-95.
11. Corsini A, Bellosta S, Baetta R, Fumagalli R, Paoletti R, Bernini F. New insights into the pharmacodynamic and pharmacokinetic properties of statins. Pharmacol Therapeut. 1999;84(3):413-28.
12. Tsiara S, Elisaf M, Mikhailidis DP. Early vascular benefits of statin therapy. Curr Med Res Opin. 2003 Jan 1;19(6):540-56.
13. Pella D, Rybar R, Mechirova V. Pleiotropic effects of statins. Acta Cardiol Sin. 2005 Dec 1;21(4):190-8.
14. Knopp RH, d'Emden M, Smilde JG, Pocock SJ. Efficacy and safety of atorvastatin in the prevention of cardiovascular end points in subjects with type 2 diabetes the atorvastatin study for prevention of coronary heart disease endpoints in non-insulin-dependent diabetes mellitus (ASPEN). Diabetes care. 2006 Jul 1;29(7):1478-85.
15. Bersot TP. Drug therapy for hypercholesterolemia and dyslipidemia. Goodman and Gilman's, The Pharmacological Basis of Therapeutics. 12th edition McGraw-Hill. 2011:877-908.
16. Kurabayashi M, Yamazaki T. Superior benefit of aggressive lipid lowering therapy for high-risk patients using statins: the SUBARU study-

more hypercholesterolemic patients achieve Japan atherosclerosis society LDL-C goals with rosuvastatin therapy than with atorvastatin therapy. J Atheroscler Thromb. 2008;15(6):314-23.
17. Liao JK. Safety and efficacy of statins in Asians. Am J Cardiol. 2007 Feb 1;99(3):410-4.
18. Lwanga SK, Lemeshow S. Sample size determination in health studies: a practical manual. World Health Organization; 1991.
19. Berne C, Siewert-Delle A. URANUS study investigators. Comparison of rosuvastatin and atorvastatin for lipid lowering in patients with type 2 diabetes mellitus: results from the URANUS study. Cardiovasc Diabetol. 2005 Jun 3;4:7.
20. Betteridge DJ, Gibson JM, Sager PT. Comparison of effectiveness of rosuvastatin versus atorvastatin on the achievement of combined C reactive protein (<2mg/L) and low-density lipoprotein cholesterol (<70mg/dl) targets in patients with type 2 diabetes mellitus. Am J Cardiol. 2007 Oct 15;100(8):1245-8.
21. Adsule S, Baig M, Gade P, Khandelwal P. A comparative evaluation of safety and efficacy of rosuvastatin, simvastatin, and atorvastatin in patients of type 2 diabetes mellitus with dyslipidemia. Int J Diabetes Dev Ctries. 2009 Apr 1;29(2):74.
22. Barakat L, Jayyousi A, Bener A, Zuby B, Zirie M. Comparison of efficacy and safety of rosuvastatin, atorvastatin and pravastatin among dyslipidemic diabetic patients. ISRN Pharmacol. 2013;2013.
23. Ogawa H, Matsui K, Saito Y, Sugiyama S, Jinnouchi H, Sugawara M, et al. Differences between rosuvastatin and atorvastatin in lipidlowering action and effect on glucose metabolism in Japanese hypercholesterolemic patients with concurrent diabetes. Circulation. 2014;78(10):2512-5.
24. Arshad AR. Comparison of low-dose rosuvastatin with atorvastatin in lipid-lowering efficacy and safety in a high-risk pakistani cohort: an open-label randomized trial. J Lipids. 2014 Mar 30;2014.
25. FDA. Information for Healthcare Professionals: Crestor (Rosuvastatin Calcium). 2016.
26. FDA. Lipitor (atorvastatin calcium) Tablets Prescribing Information. 2015.
27. Simsek S, Schalkwijk CG, Wolffenbuttel BH. Effects of rosuvastatin and atorvastatin on glycaemic control in type 2 diabetes-the CORALL study. Diabetic Med. 2012 May 1;29(5):628-31.
28. Jones PH, Davidson MH, Stein EA, Bays HE, McKenney JM, Miller E, et al. Comparison of the efficacy and safety of rosuvastatin versus atorvastatin, simvastatin, and pravastatin across doses (STELLAR Trial). Am J Cardiol. 2003 Jul 15;92(2):152-60.
29. Yamazaki T, Kurabayashi M. A randomized controlled study to compare the effects of rosuvastatin 5mg and atorvastatin 10mg on the plasma lipid profile in Japanese patients with hypercholesterolemia (ASTRO-2). Ann Vasc Dis. 2009;2(3):159-73.
30. Lee E, Ryan S, Birmingham B, Zalikowski J, March R, Ambrose H, et al. Rosuvastatin pharmacokinetics and pharmacogenetics in white and Asian subjects residing in the same environment. Clin Pharmacol Ther. 2005 Oct 1;78(4):330-41.
31. Kim KT, Birmingham BK, Azumaya CT, Chen Y, Schneck D, Zalikowski J. Increased systemic exposure to rosuvastatin in Asian subjects residing in the United States compared to Caucasian subjects. Clin Pharmacol Ther. 2008 Apr 2;83(Suppl 1):S14.