Published in final edited form as:

Semin Thorac Cardiovasc Surg. 2018 ; 30(4): 421–426. doi:10.1053/j.semtcvs.2018.07.019.

Preoperative Statin Use Not Associated with Improved Outcomes After Ascending Aortic Repair

Zachary Tyerman, MD¹, Robert B. Hawkins, MD MSc¹, J. Hunter Mehaffey, MD MSc¹, Mohammed Quader, MD², Alan Speir, MD³, Leora T. Yarboro, MD¹, and Gorav Ailawadi, MD¹

¹Division of Thoracic and Cardiovascular Surgery, University of Virginia, Charlottesville, VA

²Virginia Commonwealth University, Richmond, VA

³INOVA Heart and Vascular Institute, Falls Church, VA

Abstract

Background: Statins have potent pleiotropic effects that have been correlated with improved perioperative cardiovascular surgery outcomes. We hypothesize that statins may improve morbidity and mortality after ascending aortic surgery.

Methods: Within a statewide database consisting of 19 centers a total of 1,804 patients had ascending aortic repair with or without aortic valve replacement (2004-2016). Patients were stratified by preoperative statin therapy for analysis. To account for baseline differences, patients were propensity matched in a 1:1 fashion by baseline characteristics. Patient characteristics and outcomes were analyzed by paired analysis.

Results: Of 1,804 patients undergoing ascending aortic repair, 35% took statins preoperatively. After matching, 386 patients in each group were well matched with no statistically significant baseline or operative differences. There was no statistically significant difference in outcomes between patients taking statins preoperatively and those not taking statins, including operative mortality (3.6% vs 3.1%, $p=0.68$) and major morbidity (18.4% vs 17.1%, $p=0.62$). Postoperative atrial fibrillation (27.2% vs 28.5%, $p=0.71$) and acute kidney injury (3.1% vs 4.2%, $p=0.41$) also showed no statistically significant difference.

Conclusion: Statins have no apparent clinical impact on perioperative outcomes after ascending aortic aneurysm repair. Considering recent evidence suggesting statins may increase perioperative risk of acute kidney injury, there is insufficient evidence to recommend starting preoperative statin before ascending aortic repair.

Keywords

Aortic Disease; Aortic Aneurysm; Aortic Surgery; Statin

Corresponding Author: Gorav Ailawadi, MD, Professor and Chief, Division of Cardiovascular Surgery University of Virginia, gorav@virginia.edu Phone: (434)-924-5052.

Presentation: American Heart Association Scientific Sessions, November 12-16, 2016 in New Orleans, LA

Conflicts of interest: No conflicts of interest

Introduction

The development of HMG CoA-reductase inhibitors in the 1970s revolutionized the treatment of hyperlipidemia. Commonly referred to as “statins,” they have become one of the most commonly prescribed medication classes today due to a clear mortality benefit with primary and secondary prevention of cardiovascular disease.¹ The benefits of statins extend beyond lipid lowering properties, and these pleiotropic effects are beneficial for cardiovascular health.² Additional treatment effects include improvement in endothelial dysfunction, stabilization of atherosclerotic plaques, improved vasomotor response, and inhibition of cardiac hypertrophy. The other effects that should theoretically benefit surgical patients including anti-inflammatory properties demonstrated with lowering of C-reactive protein levels, adhesion molecule downregulation, endothelial progenitor cell recruitment, and anti-oxidant properties in myocardial cells.²⁻⁴ Statins have been associated with slowed progression and even regression in abdominal aortic aneurysms (AAA),⁵⁻⁸ but have not been well studied in thoracic aortic aneurysms (TAA). Given the similar mechanism of formation in TAA, statins could benefit the natural history of TAA, in addition to short-term patient outcomes after repair.

Multiple retrospective analyses have examined the impact of preoperative statin therapy on outcomes after non-cardiac and vascular surgery.⁹⁻¹¹ Purported benefits include reduction of atrial fibrillation, acute kidney injury, and death. Some of these same benefits have been reported in the cardiac surgical population including coronary artery bypass grafting (CABG) and valve surgery,¹²⁻¹⁶ while other studies show no difference, or even deleterious effects.^{17, 18} To date, there have been no studies evaluating ascending aortic replacement, despite evidence suggesting this disease processes is on the rise. To address this gap, we utilized the Virginia Cardiac Services Quality Initiative (VCSQI) to evaluate statins in aortic replacement. We hypothesized that patients taking statins preoperatively may have a decreased rate of mortality, major morbidity, atrial fibrillation, AKI or other complications after ascending aortic repair.

Patients and Methods

Patient Data

VCSQI is a consortium of 19 hospitals and cardiac surgery practices that perform over 99% of cardiac surgery in the state of Virginia. The Society of Thoracic Surgeons (STS) clinical data entry form is utilized by each participating center for collection of data that is then submitted to a VCSQI database. The STS data is paired with patient hospital discharge information as well as Uniform Billing (UB)-04 files (and previously UB-92 files). Estimated costs are derived from these files using publicly available cost-to-charge ratios submitted to the Center for Medicaid and Medicare Services.

De-identified patient records were extracted from the VCSQI database for all ascending aortic repair procedures for aneurysmal disease between 2004 and 2015. Specifically, only patients from STS data versions 2.52-2.81 were included based on availability of preoperative lipid lowering medication variables. Patients undergoing concomitant aortic valve replacement or aortic root replacement were included. All other major concomitant

procedures, including CABG and valves other than aortic were excluded. Patients were also excluded for a history of aortic dissection or endocarditis. After exclusions a total of 1,804 patients were included for analysis. This study was exempted from Institutional Review Board (IRB) review due to the de-identified nature of the quality database where patient level data was devoid of Health Insurance Privacy and Portability identifiers. Business associates agreements exist between VCSQI, member hospitals, and the database vendor (ARMUS Corporation, San Mateo, CA).

Measures

Standard STS definitions were used to define mortality, which includes both 30-day and in-hospital mortality. We also used the standard STS definition of major morbidity, which is a composite of permanent stroke, reoperation, prolonged ventilation, renal failure and deep sternal wound infection. The primary outcome was defined as a composite of operative mortality or major morbidity, as defined by the STS. Secondary outcomes included operative mortality, major morbidity, atrial fibrillation and renal failure.

Statistical Analysis

Patients were stratified by preoperative statin therapy for analysis. Preoperative, operative and short-term outcomes were analyzed by univariate analysis for the complete and propensity matched cohorts. Continuous variables were analyzed by Mann-Whitney U-test and reported as median with interquartile range (IQR). Categorical variables were analyzed by Chi-Square test and reported as number and percentage. Due to baseline differences patients were propensity matched in a 1:1 fashion using a logistic regression model that included relevant baseline covariates (Supplemental Table 1). Missing data for variables with <10% missing was imputed to facilitate propensity matching; continuous variables were imputed as the median (body surface area as the sex specific median), and categorical variables as the lower risk option. The matching was performed using an 8-1 digit greedy match algorithm without replacement. Adequacy of the match was assessed using absolute standardized mean difference with a threshold of <10% for all baseline variables. Adequacy of the match can be viewed in Supplemental Table 1 with absolute SMDs before and after matching as well as Supplemental Figure 1 with histograms of propensity scores before and after matching. Univariate analyses of the matched cohort were performed using Wilcoxon signed-rank and McNemar's tests where appropriate. All statistical tests were performed using SAS Version 9.4 (SAS Institute, Cary, NC) with $p < 0.05$ determining statistical significance.

Results

Baseline patient data

A total of 1,804 patients underwent ascending aortic repair for aneurysmal disease with or without aortic valve replacement between 2004 and 2016 in the Commonwealth of Virginia. As expected, significant differences exist between the two cohorts (Supplemental Table 3). The baseline characteristics of our patient cohort showed patients taking statins were older and had more comorbid disease, although operative characteristics were relatively similar (Supplemental Table 2). In the unmatched cohort, preoperative statin use was associated

with increased mortality (Preoperative Statins: 2.7% vs No Preoperative Statins: 2.0%), composite morbidity and mortality (18.7% vs 15.5%). Statins were also associated with statistically significant differences in postoperative LOS, ICU LOS, and total cost (Supplemental Table 4). Considering these differences, we decided to examine a propensity matched cohort.

A total of 772 patients were well matched with 386 per group. The standardized mean differences can be visualized in Supplemental Table 2. Demographics and baseline comorbid disease were similar across both groups (Table 1). Operative characteristics such as proportion of elective and reoperation cases, circulatory arrest time, and aortic cross clamp time were similar, as were procedure types, including rates of aortic root repair, aortic valve replacement, and ascending aorta repair (Table 2). 92% of patients in the preoperative statin group were also discharged on a statin.

Primary and Secondary Outcomes

Within the propensity-matched cohort, there was no significant difference in the composite primary outcome of operative mortality and major morbidity (Preoperative Statins: 19.5% vs No Preoperative Statins: 17.8%, $p=0.56$). The short-term outcomes are available in Table 3. Separately, both components of operative mortality (3.6% vs 3.1%, $p=0.68$) and major morbidity (18.4% vs 17.1% $p=0.62$) were similar between groups. There was no statistically significant difference in rates of atrial fibrillation (27.2% vs 28.5%, $p=0.71$) or AKI (3.1% vs 4.2%, $p=0.41$). All other secondary outcomes including permanent stroke, cardiac arrest, pneumonia, readmission, ICU and total length of stay were also not statistically different between groups (Table 3).

Discussion

This propensity matched analysis of patients undergoing ascending aortic aneurysm repair showed no difference in outcomes between those receiving preoperative statin therapy versus those without. This is in discordance with our hypothesis that preoperative statin use would result in lower rates of mortality and major morbidity, as well as improvements in atrial fibrillation and renal failure. This study marks the first time that statins have been evaluated in this specific patient population.

Multiple studies have demonstrated preoperative statin use decreases mortality in CABG and valve surgery patients.^{13, 14} However, in this propensity matched cohort there was no mortality benefit with preoperative statin use. There are two potential reasons for these results. First, the mortality benefit may be primarily seen in patients with significant coronary artery disease such as those undergoing CABG. Pan et al. hypothesized that the benefit of statins in CABG can be attributed to reduced inflammation, cardiac remodeling after surgery, attenuation of reperfusion injury, and intensive LDL reduction.¹⁴ There is more evidence within the meta-analyses for these effects in CABG, while the results are more conflicting in the valve population. Kuhn and colleagues looked at these two groups separately and noted improved mortality and other outcomes in CABG, but 4 studies of isolated AVR showed no mortality advantage with perioperative statin use.¹⁹ Alternatively, the CABG literature supporting the mortality benefit is largely derived from retrospective

analyses. The most recent prospective study evaluating the impact of preoperative statin use demonstrated no mortality benefit, despite a predominant CABG population.²⁰

Similarly, there was no statistically significant difference in the rate of major morbidity between patients on preoperative statins versus those who were not. The most relevant component is AKI. Though a difference in rate was observed, the relatively small number of observations in both groups lead to a statistically non-significant p value. This contrasts with prior observational literature, which has demonstrated an association with decreased AKI in patients receiving statins preoperatively.^{21,24} However, a recent randomized controlled trial by Zheng and colleagues demonstrated increased AKI with preoperative statin use in patients undergoing CABG, aortic valve replacement, or both.²⁰ Additionally, another randomized controlled trial by Billings et al suggested deleterious effects of preoperative statin use on post-operative renal function in patients undergoing CABG, valve surgery, or both.²⁵ In this study, the subset of patients naïve to statin therapy who receive preoperative statins had higher rates of AKI (RR, 1.61; 95% CI, 0.86-3.01). This trial ceased on the grounds of futility, and underscores the risk of starting statins in pursuit of short term perioperative benefits.

Finally, our study demonstrated no difference in the rate of postoperative atrial fibrillation between groups. Just as with AKI, statins are believed to effect atrial fibrillation by attenuating the inflammatory state after cardiac surgery.^{3,4} Our findings contradict studies with coronary or heterogenous cardiac populations that demonstrated reduced atrial fibrillation rates with preoperative statin use.²⁶⁻³³ Studies, including meta-analyses, in the isolated valve population failed to demonstrate a clinical benefit of statin use in reducing atrial fibrillation rates.^{19,34,35} Though there is some retrospective evidence supporting preoperative statin use reducing atrial fibrillation in CABG, prospective trials and valve specific data support our results that statin use in the aortic aneurysm population likely does not reduce postoperative atrial fibrillation rates.

As a retrospective study this analysis has several limitations including the inability to prove causation, which would require a randomized controlled trial in thoracic aortic aneurysm population. At baseline, patients taking statins have significant differences in aggregate compared to those not taking statins. This limitation was addressed with propensity score matching, although it is only able to analyze a subset of the entire aortic repair population. Additionally, due to deidentification of VSCQI data, detailed patient information such as dose and duration of statin treatment is not available. Indication for treatment is also not available, but we think that it is reasonable to speculate patients were started on the drug for clinical reasons. Furthermore, In our dataset, details on preoperative statin use is limited to whether the patient was on the medication within 24 hours of surgery. The dataset is also limited to short term outcomes, and information on long term benefits of statin use in ascending aortic surgery are not available. Finally, as with any database, VCSQI is limited by the variables available and is at risk for coding errors, although STS data represents some of the highest quality data available.

Although there is enthusiasm for preoperative statin use in cardiac surgery patients, our current study demonstrates no benefit in short-term outcomes in patients undergoing

ascending aortic aneurysm operations. While statins may ultimately demonstrate long-term benefits in attenuating aortic aneurysm progression, there is no short-term benefit to statin use in this patient population, particularly in the perioperative setting. Evidence supports no change in patients' statin use prior to ascending aortic repair, as there is no evidence stopping statins is beneficial and there may be increased risk for AKI in statin-naïve patients.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Funding Source: NIH T32 Grant (T32 HL07849)

Abbreviations

AAA	Abdominal Aortic Aneurysms
TAA	Thoracic Aortic Aneurysms
ASMD	Absolute Standardized Mean Difference
AF	Atrial Fibrillation
AKI	Acute Kidney Injury
MI	Myocardial Infarction
CPB	Cardiopulmonary Bypass
LVEF	Left Ventricular Ejection Fraction
CLD	Chronic Lung Disease
LOS	Length Of Stay
IQR	Interquartile Range
STS	Society of Thoracic Surgeons
VCSQI	Virginia Cardiac Services Quality Initiative

References

1. Chou R, Dana T, Blazina I, Daeges M, Jeanne TL. Statins for Prevention of Cardiovascular Disease in Adults: Evidence Report and Systematic Review for the US Preventive Services Task Force. *JAMA*. 2016;316:2008–2024. [PubMed: 27838722]
2. Davignon J Beneficial cardiovascular pleiotropic effects of statins. *Circulation*. 2004;109:III39–43. [PubMed: 15198965]
3. Antoniadou C, Demosthenous M, Reilly S, et al. Myocardial redox state predicts in-hospital clinical outcome after cardiac surgery effects of short-term pre-operative statin treatment. *J Am Coll Cardiol*. 2012;59:60–70. [PubMed: 22192670]
4. Sodha NR, Sellke FW. The effect of statins on perioperative inflammation in cardiac and thoracic surgery. *J Thorac Cardiovasc Surg*. 2015;149:1495–1501. [PubMed: 25791954]

5. Li Y, Lu G, Sun D, Zuo H, Wang DW, Yan J. Inhibition of endoplasmic reticulum stress signaling pathway: A new mechanism of statins to suppress the development of abdominal aortic aneurysm. *PLoS One*. 2017;12:e0174821. [PubMed: 28369137]
6. Yoshimura K, Nagasawa A, Kudo J, et al. Inhibitory effect of statins on inflammation-related pathways in human abdominal aortic aneurysm tissue. *Int J Mol Sci*. 2015;16:11213–11228. [PubMed: 25993292]
7. Gray C, Goodman P, O'Malley MK, O'Donohoe MK, McDonnell CO. Statins promote residual aneurysm sac regression following endovascular aortic aneurysm repair. *Vasc Endovascular Surg*. 2014;48:111–115. [PubMed: 24347280]
8. Periard D, Guessous I, Mazzolai L, Haesler E, Monney P, Hayoz D. Reduction of small infrarenal abdominal aortic aneurysm expansion rate by statins. *Vasa*. 2012;41:35–42. [PubMed: 22247058]
9. Bhavé PD, Goldman LE, Vittinghoff E, Maselli JH, Auerbach A. Statin use and postoperative atrial fibrillation after major noncardiac surgery. *Heart Rhythm*. 2012;9:163–169. [PubMed: 21907173]
10. de Bruin JL, Baas AF, Heymans MW, et al. Statin therapy is associated with improved survival after endovascular and open aneurysm repair. *J Vasc Surg*. 2014;59:39–44 e31. [PubMed: 24144736]
11. Galinanes EL, Reynolds S, Dombrovskiy VY, Vogel TR. The impact of preoperative statin therapy on open and endovascular abdominal aortic aneurysm repair outcomes. *Vascular*. 2015;23:344–349. [PubMed: 25315791]
12. Bellomo R Perioperative Statins in Cardiac Surgery and Acute Kidney Injury. *JAMA*. 2016;315:873–874. [PubMed: 26905755]
13. Fedoruk LM, Wang H, Conaway MR, Kron IL, Johnston KC. Statin therapy improves outcomes after valvular heart surgery. *Ann Thorac Surg*. 2008;85:1521–1525; discussion 1525–1526. [PubMed: 18442531]
14. Pan W, Pintar T, Anton J, Lee VV, Vaughn WK, Collard CD. Statins are associated with a reduced incidence of perioperative mortality after coronary artery bypass graft surgery. *Circulation*. 2004;110:II45–49. [PubMed: 15364837]
15. Pierri MD, Crescenzi G, Zingaro C, et al. Prevention of atrial fibrillation and inflammatory response after on-pump coronary artery bypass using different statin dosages: a randomized, controlled trial. *Gen Thorac Cardiovasc Surg*. 2016;64:395–402. [PubMed: 27075863]
16. Singh I, Rajagopalan S, Srinivasan A, et al. Preoperative statin therapy is associated with lower requirement of renal replacement therapy in patients undergoing cardiac surgery: a meta-analysis of observational studies. *Interact Cardiovasc Thorac Surg*. 2013;17:345–352. [PubMed: 23628654]
17. Putzu A, Capelli B, Belletti A, et al. Perioperative statin therapy in cardiac surgery: a meta-analysis of randomized controlled trials. *Crit Care*. 2016;20:395. [PubMed: 27919293]
18. Zen B, Rossi L, Rosa EM. Statin in prevention of atrial fibrillation after cardiac surgery. *Arq Bras Cardiol*. 2011;96:516. [PubMed: 21789348]
19. Kuhn EW, Liakopoulos OJ, Stange S, et al. Meta-analysis of patients taking statins before revascularization and aortic valve surgery. *Ann Thorac Surg*. 2013;96:1508–1516. [PubMed: 23993896]
20. Zheng Z, Jayaram R, Jiang L, et al. Perioperative Rosuvastatin in Cardiac Surgery. *N Engl J Med*. 2016;374:1744–1753. [PubMed: 27144849]
21. Molnar AO, Parikh CR, Coca SG, et al. Association between preoperative statin use and acute kidney injury biomarkers in cardiac surgical procedures. *Ann Thorac Surg*. 2014;97:2081–2087. [PubMed: 24725831]
22. Molnar AO, Coca SG, Devereaux PJ, et al. Statin use associates with a lower incidence of acute kidney injury after major elective surgery. *J Am Soc Nephrol*. 2011;22:939–946. [PubMed: 21493769]
23. Brunelli SM, Waikar SS, Bateman BT, et al. Preoperative statin use and postoperative acute kidney injury. *Am J Med*. 2012;125:1195–1204 e1193. [PubMed: 23062398]
24. Wang J, Gu C, Gao M, Yu W, Yu Y. Preoperative Statin Therapy and Renal Outcomes After Cardiac Surgery: A Meta-analysis and Meta-regression of 59,771 Patients. *Can J Cardiol*. 2015;31:1051–1060. [PubMed: 26081692]

25. Billings FTt, Hendricks PA, Schildcrout JS, et al. High-Dose Perioperative Atorvastatin and Acute Kidney Injury Following Cardiac Surgery: A Randomized Clinical Trial. *JAMA*. 2016;315:877–888. [PubMed: 26906014]
26. An J, Shi F, Liu S, Ma J, Ma Q. Preoperative statins as modifiers of cardiac and inflammatory outcomes following coronary artery bypass graft surgery: a meta-analysis. *Interact Cardiovasc Thorac Surg*. 2017.
27. Liakopoulos OJ, Choi YH, Haldenwang PL, et al. Impact of preoperative statin therapy on adverse postoperative outcomes in patients undergoing cardiac surgery: a meta-analysis of over 30,000 patients. *Eur Heart J*. 2008;29:1548–1559. [PubMed: 18506053]
28. Zhen-Han L, Rui S, Dan C, Xiao-Li Z, Qing-Chen W, Bo F. Perioperative statin administration with decreased risk of postoperative atrial fibrillation, but not acute kidney injury or myocardial infarction: A meta-analysis. *Sci Rep*. 2017;7:10091. [PubMed: 28855628]
29. Kuhn EW, Liakopoulos OJ, Stange S, et al. Preoperative statin therapy in cardiac surgery: a meta-analysis of 90,000 patients. *Eur J Cardiothorac Surg*. 2014;45:17–26; discussion 26. [PubMed: 23562936]
30. Yuan X, Du J, Liu Q, Zhang L. Defining the role of perioperative statin treatment in patients after cardiac surgery: A meta-analysis and systematic review of 20 randomized controlled trials. *Int J Cardiol*. 2017;228:958–966. [PubMed: 27914358]
31. Patti G, Bennett R, Seshasai SR, et al. Statin pretreatment and risk of in-hospital atrial fibrillation among patients undergoing cardiac surgery: a collaborative meta-analysis of 11 randomized controlled trials. *Europace*. 2015;17:855–863. [PubMed: 25733550]
32. Goh SL, Yap KH, Chua KC, Chao VT. Does preoperative statin therapy prevent postoperative atrial fibrillation in patients undergoing cardiac surgery? *Interact Cardiovasc Thorac Surg*. 2015;20:422–428. [PubMed: 25476462]
33. Kourliouros A, De Souza A, Roberts N, et al. Dose-related effect of statins on atrial fibrillation after cardiac surgery. *Ann Thorac Surg*. 2008;85:1515–1520. [PubMed: 18442529]
34. Folkerlinga RJ, Tieleman RG, Maessen JG, Prins MH, Nieuwlaet R, Crijns HJ. Statins Do Not Reduce Atrial Fibrillation After Cardiac Valvular Surgery: A Single Centre Observational Study. *Neth Heart J*. 2011;19:17–23. [PubMed: 21350586]
35. Virani SS, Nambi V, Lee VV, et al. Does preoperative statin therapy improve outcomes in patients undergoing isolated cardiac valve surgery? *Am J Cardiol*. 2008; 102:1235–1239. [PubMed: 18940299]

Central Image: Flow chart of our propensity score match process, and histogram of major outcomes in ascending aortic surgery by statin use

Table 1:

VCSQI Matched Cohort baseline patient demographics and comorbidities

<i>Baseline characteristics</i>	Statin (n = 386)	No Statin (n = 386)	p value
Age (years; median, IQR)	62 [55-69]	63 [54-71]	0.86
Female	139 (33.7%)	127 (32.9%)	0.82
BMI (median, IQR)	28.7 [26-32]	28.7 [25-32]	0.65
Dyslipidemia	334 (86.6%)	335 (86.8%)	0.66
Smoker	95 (24.6%)	116 (30.5%)	0.09
Hypertension	293 (75.9%)	306 (79.3%)	0.26
Diabetes	59 (15.3%)	58 (15.0%)	0.91
Insulin depended diabetes	13 (3.4%)	14 (3.6%)	0.85
Dialysis dependent renal failure	2 (0.5%)	5 (1.3%)	0.26
Recent heart failure symptoms	93 (24.1%)	102 (26.4%)	0.45
Peripheral arterial disease	52 (13.5%)	48 (12.4%)	0.66
Cerebral vascular disease	53 (13.7%)	52 (13.5%)	0.91
Coronary artery disease	59 (15.3%)	55 (14.2%)	0.68
Aortic insufficiency	158 (40.9%)	159 (41.2%)	0.94
Aortic stenosis	189 (49.0%)	179 (46.4%)	0.47
Mitral regurgitation	31 (8.0%)	28 (7.3%)	0.70
Mitral stenosis	4 (1.0%)	2 (0.5%)	0.41
Tricuspid regurgitation	18 (4.7%)	19 (4.9%)	0.87
Previous CABG	17 (4.4%)	13 (3.4%)	0.45
Previous valve	52 (13.5%)	42 (10.9%)	0.28
Prior stroke	23 (6.0%)	22 (5.7%)	0.88
CLD (moderate/severe)	29 (7.5%)	28 (7.3%)	0.88
Prior myocardial infarction	24 (6.2%)	23 (6.0%)	0.85
LVEF (%; median, IQR)	60 [55-63]	60 [55-63]	0.65

BMI = body mass index; CLD = chronic lung disease; LVEF = left ventricular ejection fraction; IQR = interquartile range; CABG = coronary artery bypass graft

Table 2:

VCSQI Matched Cohort patient operative characteristics

	Statin (n=386)	No Statin (n=386)	p value
CPB time (min; median, IQR)	135 [109-180]	141 [106-186]	0.65
Cross clamp time (min; median, IQR)	98 [76-136]	98 [71-136]	0.57
Ascending aorta repair	332 (86.0%)	330 (85.5%)	0.84
Aortic root repair	170 (44.0%)	169 (43.8%)	0.95
Aortic valve replacement	321 (83.2%)	313 (81.1%)	0.45
Circulatory Arrest	72 (18.7%)	81 (21.0%)	0.43
Elective	345 (89.4%)	339 (87.8%)	0.41
Reoperation	67 (17.4%)	64 (16.6%)	0.77

CPB = cardiopulmonary bypass; IQR = interquartile range

Table 3:

VCSQI Matched Cohort outcomes

<i>Outcomes</i>	Statin (n = 386)	No Statin (n = 386)	p value
Operative mortality	14 (3.6%)	12 (3.1%)	0.68
Major morbidity	71 (18.4%)	66 (17.1%)	0.62
Morbidity or Mortality	75 (19.5%)	69 (17.8%)	0.56
Permanent stroke	11 (2.9%)	12 (3.1%)	0.83
Cardiac arrest	13 (3.4%)	10 (2.6%)	0.53
Atrial fibrillation	105 (27.2%)	110 (28.5%)	0.71
Pneumonia	8 (2.1%)	8 (2.1%)	1.00
Prolonged ventilation	46 (11.9%)	46 (11.9%)	1.00
Acute kidney injury	12 (3.1%)	16 (4.2%)	0.41
Renal failure requiring dialysis	8 (2.1%)	13 (3.4%)	0.22
Deep sternal wound infection	0	0	0.00
Blood product transfusion	133 (34.5%)	134 (34.7%)	0.94
Reoperation for any reason	31 (8.0%)	23 (6.0%)	0.23
Reoperation for bleeding	21 (5.4%)	17 (4.4%)	0.52
Readmission	50 (13.9%)	40 (10.9%)	0.37
Discharge to facility	47 (12.6%)	53 (14.2%)	0.50
Postoperative LOS (days; median, IQR)	5 [4-8]	5 [4-8]	0.75
ICU LOS (hours; median, IQR)	45 [26-75]	47 [26-82]	0.48

PRBC = packed red blood cells; LOS = length of stay; ICU = intensive care unit; IPPS = inpatient prospective payment system