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Obesity in Diabetic Patients Undergoing Coronary Artery Bypass Graft Surgery Is Associated with Increased Postoperative Morbidity

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Background: **Despite the fact that obesity is a known risk factor for cardiovascular disease, many studies have failed to demonstrate that obesity is independently associated with an increased risk of cardiovascular morbidity and mortality in nondiabetic patients undergoing coronary artery bypass graft surgery. The authors investigated the influence of obesity on adverse postoperative outcomes in diabetic and nondiabetic patients after primary coronary artery bypass surgery.**

Methods: **A retrospective cohort study of patients undergoing primary coronary artery bypass surgery (n = 9,862) between January 1995 and December 2004 at the Texas Heart Institute was performed. Diabetic (n = 3,374) and nondiabetic patients (n = 6,488) were classified into five groups, according to their body mass index: normal weight (n = 2,148), overweight (n = 4,257), mild obesity (n = 2,298), moderate obesity (n = 785), or morbid obesity (n = 338). Multivariate, stepwise logistic regression was performed controlling for patient demographics, medical history, and preoperative medications to determine whether obesity was independently associated with an increased risk of adverse postoperative outcomes.**

Results: **Obesity in nondiabetic patients was not independently associated with an increased risk of adverse postoperative outcomes. In contrast, obesity in diabetic patients was independently associated with a significantly increased risk of postoperative respiratory failure (odds ratio [OR], 2.26; 95% confidence interval [CI], 1.41–3.61; $P < 0.001$), ventricular tachycardia (OR, 2.27; 95% CI, 1.18–4.35; $P < 0.02$), atrial fibrillation (OR, 1.56; 95% CI, 1.03–2.38; $P < 0.04$), atrial flutter (OR, 2.38; 95% CI, 1.29–4.40; $P < 0.01$), renal insufficiency (OR, 1.66; 95% CI, 1.10–3.41; $P < 0.03$), and leg wound infection (OR, 5.34; 95% CI, 2.27–12.54; $P < 0.001$). Obesity in diabetic patients was not independently associated with an increased risk of mortality, stroke, myocardial infarction, sepsis, or sternal wound infection.**

Conclusion: **Obesity in diabetic patients is an independent predictor of worsened postoperative outcomes after primary coronary artery bypass graft surgery.**

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OBESITY and diabetes are key features of the metabolic syndrome, a cluster of metabolic abnormalities that includes hypertension and dyslipidemia.[1] Patients with metabolic syndrome are at greater risk of development of atherosclerotic cardiovascular events compared with nondiabetic, obese patients.[2] Although the underlying mechanisms have yet to be fully elucidated, increasing evidence suggests that the combination of obesity and diabetes is associated with increased systemic inflammation, endothelial dysfunction, and thrombogenicity, which may consequently promote accelerated atherosclerosis of the microvasculature and macrovasculature.[3–6] Obesity is also associated with increased proinflammatory cytokine levels, including tumor necrosis factor α, interleukin 6, and C-reactive protein, all of which are also mediators of insulin resistance.[4–8] Insulin resistance in turn promotes the activation of multiple proinflammatory cellular transcription factors (*e.g.*, nuclear factor κB, activated protein 1), which act to maintain the inflammatory state.[9] Insulin resistance also results in decreased lipid metabolism (*e.g.*, decreased apolipoprotein biosynthesis, increased low-density lipoprotein concentrations), further increasing the risk of atherosclerosis and endothelial dysfunction.[10,11]

Multiple clinical studies have investigated whether obesity is an independent predictor of postoperative cardiovascular morbidity and mortality after coronary artery bypass graft (CABG) surgery (table 1). However, despite being a well-known risk factor for cardiac disease, many clinical studies have failed to demonstrate that obesity is independently associated with an increased risk of in-hospital mortality and adverse postoperative outcomes, including death, myocardial infarction (MI), stroke, and renal failure.[12–31] The single most consistent finding among these studies to date is that obesity may independently predict an increased risk of postoperative wound infection.[12–17,20–24] Nonetheless, several studies have suggested that obesity may be an independent predictor of postoperative death and atrial arrhythmias.[12,13,15,32–36]

In contrast to nondiabetic obese patients, obese patients with diabetes may be at greater risk for systemic proinflammatory and thrombotic states and are thus more likely to have worsened postoperative outcomes after CABG surgery. Therefore, the aim of the current study was to investigate whether obesity is an independent predictor of increased postoperative morbidity and

Table 1. Summary of Clinical Trials Previously Investigating Whether Obesity Is an Independent Risk Factor for Postoperative Morbidity and Mortality after CABG Surgery

Study (n = 25)	Patients, n	Death	MI	AAs	Stroke	RF	RI	Bleeding	SWI
Shuhaiber *et al.*[32] (1987)	170	Y							Y
Edwards *et al.*[33] (1998)	344,913	Y							
Hollenbeak *et al.*[34] (2000)	160	Y							
Weiss *et al.*[35] (2000)	466					Y			
Prahabkar *et al.*[36] (2002)	559,004	Y							
Prasad *et al.*[12] (1991)	250	N	Y	Y					Y
Moulton *et al.*[13] (1996)	2,299	N	N	Y	N		N	N	Y
Noyez *et al.*[14] (2000)	3,815	N							Y
Gardlund *et al.*[15] (2001)	126			Y					
Ridderstolpe *et al.*[16](2001)	3,008								Y
Kuduvalli *et al.*[21] (2002)	4,713	N	N	Y	N		N		Y
Schwann *et al.*[17] (2001)	3,560	N	N	N	N		N	N	Y
Clough *et al.*[18] (2002)	27,239	N							
Gurm *et al.*[19] (2002)	1,526	N							
Olsen *et al.*[20] (2002)	1,980								Y
Potapov *et al.*[22] (2002)	22,666	N	N	N	N		N	N	Y
Russo and Spelman[23] (2002)	3,000								Y
Lindhout *et al.*[24] (2004)	1,130	N	N	N	N		N	N	Y
Christiakis *et al.*[25] (1995)	7,025	N	N	N	N	N	N	N	N
Brandt *et al.*[26] (2001)	500	N	N	N	N	N	N	N	N
Reeves *et al.*[27] (2002)	4,372	N	N	N	N	N	N	N	N
Rockx *et al.*[28] (2004)	1,310	N	N	N	N	N	N	N	N
Jin *et al.*[29] (2005)	16,218	N							
Birkmeyer *et al.*[30] (1998)	11,101	N	N	N	N	N	N	Y (lower)	Y
Kim *et al.*[31] (2003)	6,728	N	N	N	N	N	N	Y (lower)	Y

AA = atrial arrhythmia; CABG = coronary artery bypass graft; MI = myocardial infarction; RF = renal failure; RI = respiratory insufficiency; SWI = sternal wound infection.

mortality in diabetic and nondiabetic patients undergoing primary CABG surgery.

Materials and Methods

Study Design

This retrospective cohort study was performed on all patients undergoing primary CABG surgery with cardiopulmonary bypass at the Texas Heart Institute, St. Luke's Episcopal Hospital, Houston, Texas, between January 1995 and December 2004 (n = 9,862), after obtaining approval of the institutional review board. Obesity was assessed using body mass index (BMI), calculated as weight (kg)/height squared (m^2).[37] Diabetic (n = 3,374) and nondiabetic patients (n = 6,488) were classified into one of five groups at the time of surgery using the World Health Organization definition for obesity (table 2): normal weight (BMI 20.0–24.9 kg/m^2; n = 2,184), overweight (BMI 25.0–29.9 kg/m^2; n = 4,257), mild obesity (BMI 30.0–34.9 kg/m^2; n = 2,298), moderate obesity (BMI 35.0–39.9 kg/m^2; n = 785), or morbid obesity (BMI $\geq$ 40.0 kg/m^2; n = 338).[38] Patients were classified as being diabetic based on their admission diagnosis or if they were receiving preoperative insulin or oral hypoglycemic agents at the time of admission. Patients undergoing emergent surgery or concomitant valve or other cardiac surgery (*e.g.*, atrial septum defect repair, ventricular aneurysm resection) and patients who were underweight (BMI $<$ 20.0 kg/m^2) were excluded from the study.

Data Collection

Patient demographics, preoperative and intraoperative operative risk factors, and the incidence of adverse postoperative outcomes were obtained from the Texas Heart Institute cardiac surgical database.[39] Measured adverse postoperative outcomes included 30-day all-cause mortality, MI, cardiac arrhythmias, respiratory failure, stroke, renal dysfunction, infection, and need for mediastinal reexploration. A diagnosis of MI was made if there were new Q waves (Minnesota code 1-1-1 to 1-2-7), new per-

Table 2. Number of Diabetic and Nondiabetic Patients in Each Group

	Normal Weight (BMI 20–24 kg/m^2), n	Overweight (BMI 25–29 kg/m^2), n	Mild Obesity (BMI 30–34 kg/m^2), n	Moderate Obesity (BMI 35–39 kg/m^2), n	Morbid Obesity (BMI > 40 kg/m^2), n	Total, n
Nondiabetic patients	1,605	2,927	1,404	399	153	6,488
Diabetic patients	579	1,330	894	386	185	3,374
Total	2,184	4,257	2,298	785	338	9,862

BMI = body mass index.

Table 3. Preoperative Demographic Variables and Risk Factors in Nondiabetic Patients (n = 6,488) Undergoing Primary CABG Surgery

Patient Demographic	Normal Weight (n = 1,605)	Overweight (n = 2,927)	Mild Obesity (n = 1,404)	Moderate Obesity (n = 399)	Morbid Obesity (n = 153)	*P* Value (Chi-square Analysis)
Age, yr	66 ± 11	63 ± 11	60 ± 10	60 ± 11	59 ± 11	< 0.0001
Female sex, %	27	17	21	24	27	< 0.0001
Smoker, %	51	52	53	60	56	< 0.02
Renal insufficiency, %	13	10	10	11	9	< 0.04
Hypertension, %	64	68	76	81	76	< 0.0001
Left main CAD, %	25	25	24	21	23	0.40
Triple-vessel CAD, %	54	53	50	49	47	< 0.03
Prior myocardial infarction, %	44	42	41	41	43	0.40
Unstable angina, %	57	54	56	55	56	0.50
Ejection fraction < 50%, %	37	35	34	30	37	0.17
Congestive heart failure, %	15	11	12	15	14	< 0.001
Transient ischemic attack, %	4	3	3	3	1	0.35
Stroke, %	6	4	4	4	5	< 0.03
Pulmonary disease, %	27	22	22	27	18	< 0.0001
Hyperlipidemia, %	54	63	63	64	62	< 0.0001
β Blockers, %	42	47	46	52	42	0.36
Calcium channel blockers, %	27	26	28	27	33	0.42
Aspirin, %	62	64	64	63	58	0.32
Antiarrhythmics, %	5	4	4	3	5	0.40
Diuretics, %	15	14	17	23	22	0.28
Statins, %	71	76	73	73	63	0.15
Cross clamp time, min	37 ± 19	37 ± 19	39 ± 20	37 ± 18	37 ± 17	0.12
Total bypass time, min	64 ± 28	64 ± 29	67 ± 33	67 ± 32	66 ± 31	0.08

Data are presented as mean ± SEM or n (%).

CABG = coronary artery bypass graft; CAD = coronary artery disease.

sistent ST-segment or T-wave changes (Minnesota code 4-1, 4-2, 5-1, 5-2, or 9-2), serum troponin elevation greater than 10 ng/ml, or clinical evidence of acute MI on autopsy. A diagnosis of stroke was made if there was clinical evidence; or evidence of a new focal or global defect on computed tomography, magnetic resonance imaging, or autopsy. Renal dysfunction was defined as a serum creatinine level of at least 2.0 mg/dl, accompanied by an increase of at least 0.7 mg/dl from baseline; renal failure requiring dialysis; or evidence of renal failure on autopsy. Intraoperative blood glucose levels were measured and treated according to individual physicians' discretion. Postoperatively, a standardized sliding scale insulin regimen was used to maintain the blood glucose levels between 80 and 140 mg/dl.

Statistical Analysis

All statistical analyses were performed using SAS statistical software (SAS Institute, Cary, NC). Patient preoperative demographics, risk factors, and preoperative medications were first compared between groups by univariate (chi-square) analysis. All predictor variables significant at a two-tailed nominal *P* value of less than 0.15 in the univariate analysis were then entered into a multivariate logistical model, and stepwise logistic regression was performed to determine whether obesity was independently associated with an increased risk of adverse postoperative outcomes in diabetic and nondiabetic patients after primary CABG surgery. Only those variables significant at a two-tailed nominal *P* value of less than 0.05 were retained within the model. Odds ratios (ORs) and corresponding 95% confidence intervals (CIs) are reported, with associated *P* values. A c-statistic was calculated for each outcome to quantify the discriminatory power of the multivariate regression model.

Results

Preoperative demographics and risk factors in nondiabetic and diabetic patients are presented in tables 3 and 4, respectively. Of note, the five BMI groups did not significantly differ with respect to age, history of previous MI, unstable angina, ejection fraction less than 50%, stroke, or preoperative medications. Furthermore, no significant differences in intraoperative risk factors (*e.g.*, aortic cross clamp time, cardiopulmonary bypass time) were observed among groups. As expected, the incidence of hyperlipidemia was significantly increased in morbidly obese, diabetic, and nondiabetic patients compared with normal-weight patients ($P < 0.001$). Obese diabetic and nondiabetic patients were significantly younger than normal-weight patients at the time of surgery ($P < 0.0001$). Further, in diabetic patients (table 4), the incidence of hypertension seemed to increase directly with increasing BMI ($P < 0.0001$).

The incidence of adverse postoperative outcomes in nondiabetic patients is presented in table 5. In nondiabetic patients undergoing CABG surgery, obesity was

Table 4. Preoperative Demographic Variables and Risk Factors in Diabetic Patients (n = 3,374) Undergoing Primary CABG Surgery

Patient Demographic	Normal Weight (n = 579)	Overweight (n = 1,330)	Mild Obesity (n = 894)	Moderate Obesity (n = 386)	Morbid Obesity (n = 185)	*P* Value (Chi-square Analysis)
Age, yr	66 ± 10	64 ± 10	62 ± 9	61 ± 10	57 ± 10	< 0.0001
Female sex, %	32	27	30	42	48	< 0.0001
Smoker, %	45	49	49	47	43	0.33
Renal insufficiency, %	20	15	15	15	11	< 0.03
Hypertension, %	72	82	84	90	95	< 0.0001
Left main CAD, %	23	21	19	19	18	0.19
Triple-vessel CAD, %	64	64	62	58	56	0.13
Prior myocardial infarction, %	47	47	46	46	40	0.54
Unstable angina, %	52	52	53	55	53	0.86
Ejection fraction < 50%, %	48	46	43	40	42	0.14
Congestive heart failure, %	25	23	24	27	31	0.09
Transient ischemic attack, %	5	4	3	3	3	0.56
Stroke, %	10	8	8	10	4	0.19
Pulmonary disease, %	27	22	25	30	28	< 0.02
Hyperlipidemia, %	54	61	65	62	67	< 0.001
β Blocker, %	40	45	45	46	50	0.15
Calcium channel blocker, %	31	29	29	32	34	0.21
Aspirin, %	60	61	62	62	58	0.33
Antiarrhythmics, %	6	6	3	4	5	0.38
Diuretics, %	22	21	27	33	42	0.15
Statins, %	61	72	74	70	68	0.16
Cross clamp time, min	39 ± 20	40 ± 20	41 ± 21	41 ± 24	39 ± 19	0.41
Total bypass time, min	67 ± 31	68 ± 33	72 ± 34	71 ± 36	70 ± 30	0.06

Data are presented as mean ± SEM or n (%).

CABG = coronary artery bypass graft; CAD = coronary artery disease.

not found to be independently associated with any measured adverse postoperative outcome, including mortality, MI, arrhythmias, stroke, or infection. Consistent with previous reports, the incidence of mediastinal reexploration in morbidly obese patients was significantly decreased compared with normal-weight patients (7.0 *vs.* 1.3%; $P < 0.05$).[30,31]

The incidence of adverse postoperative outcomes in diabetic patients is presented in table 6. In contrast to nondiabetic patients, the incidences of respiratory failure (20.0 *vs.* 12.1%), atrial fibrillation (22.2 *vs.* 18.6%), atrial flutter (10.8 *vs.* 4.8%), ventricular tachycardia (9.2 *vs.* 4.7%), renal insufficiency (12.4 *vs.* 7.4%), leg wound infection (8.1 *vs.* 1.6%), and duration of hospital stay (14.3 ± 12.7 *vs.* 11.5 ± 8.7 days) were significantly greater in morbidly obese patients compared with normal-weight patients, respectively (all outcomes $P < 0.05$). Furthermore, multivariate analysis controlling for

Table 5. Incidence of Adverse Postoperative Outcomes in Nondiabetic Patients (n = 6,488) after Primary CABG Surgery

Postoperative Outcome	Normal Weight (n = 1,605)	Overweight (n = 2,927)	Mild Obesity (n = 1,404)	Moderate Obesity (n = 399)	Morbid Obesity (n = 153)
30-Day mortality, %	4.3	2.4	2.8	1.9	2.1
Respiratory failure, %	9.2	8.2	9.9	11.5	9.9
Atrial fibrillation, %	21.2	19.0	17.0	18.3	18.3
Atrial flutter, %	6.2	6.4	5.3	7.8	5.9
Ventricular fibrillation, %	4.7	2.7	2.6	1.5	4.6
Ventricular tachycardia, %	6.1	5.1	5.7	6.0	4.6
Renal insufficiency, %	5.1	4.6	4.6	7.0	7.9
Stroke, %	2.6	2.2	1.4	1.5	0.7
Myocardial infarction, %	3.9	2.5	3.5	4.0	3.3
Mediastinal reexploration, %	7.0	3.9*	3.1*	3.8*	1.3*
Postoperative IABP, %	5.1	3.4	3.6	3.0	4.3
Sepsis, %	1.5	1.3	1.3	1.8	2.0
Sternal wound infection, %	0.3	0.1	0.5	0.8	0.7
Leg wound infection, %	1.4	1.8	2.4	3.3	2.6
Hospital stay, days	10.6 ± 8.2	9.4 ± 6.4	9.3 ± 5.5	10.1 ± 7.2	10.4 ± 5.2

Data are presented as mean ± SEM or n (%).

* $P < 0.05$ compared with the normal-weight group.

CABG = coronary artery bypass graft; IABP = intraaortic balloon pump.

Table 6. Incidence of Adverse Postoperative Outcomes in Diabetic Patients (n = 3,374) after Primary CABG Surgery

Postoperative Outcome	Normal Weight (n = 579)	Overweight (n = 1,330)	Mild Obesity (n = 894)	Moderate Obesity (n = 386)	Morbid Obesity (n = 185)
30-Day mortality, %	5.9	4.1	3.9	5.2	5.4
Respiratory failure, %	12.1	11.7	13.7*	15.5*	20.0*
Atrial fibrillation, %	18.6	21.5	18.6	19.7	22.2*
Atrial flutter, %	4.8	6.8	5.4	7.0	10.8*
Ventricular fibrillation, %	5.2	3.8	4.6	4.4	1.6
Ventricular tachycardia, %	4.7	6.0	7.0*	7.5*	9.2*
Renal insufficiency, %	7.4	7.7	9.1*	10.6*	12.4*
Stroke, %	4.8	4.7	2.6	4.9	2.2
Myocardial infarction, %	2.1	3.4	2.7	2.6	4.3
Mediastinal reexploration, %	4.8	4.9	3.0	4.4	4.3
Postoperative IABP, %	5.0	5.2	5.8	5.7	6.5
Sepsis, %	2.6	2.4	2.5	2.3	4.3
Sternal wound infection, %	0.0	0.9	1.5	0.8	1.1
Leg wound infection, %	1.6	2.0	3.6*	6.0*	8.1*
Hospital stay, days	11.5 ± 8.7	11.9 ± 14.7	12.0 ± 9.7	12.9 ± 11.6	14.3 ± 12.7*

Data are presented as mean ± SEM or n (%).

* $P < 0.05$ compared with the normal-weight group.

CABG = coronary artery bypass graft; IABP = intraaortic balloon pump.

preoperative demographics, risk factors, medications, and intraoperative risk factors revealed that obesity was independently associated with an increased risk of respiratory failure (OR, 2.26; 95% CI, 1.41–3.61; $P < 0.001$), ventricular tachycardia (OR, 2.27; 95% CI, 1.18–4.35; $P < 0.02$), atrial fibrillation (OR, 1.56; 95% CI, 1.03–2.38; $P < 0.04$), atrial flutter (OR, 2.38; 95% CI, 1.29–4.40; $P < 0.01$), renal insufficiency (OR, 1.66; 95% CI, 1.10–3.41; $P < 0.03$), and leg wound infection (OR, 5.34; 95% CI, 2.27–12.54; $P < 0.001$). Risk-adjusted ORs for adverse postoperative outcomes independently associated with morbid obesity in diabetic patients are presented in figure 1. The c-statistic for these outcomes ranged from 0.64 to 0.74. No significant differences were observed with respect to the incidence of 30-day all-cause mortality, ventricular fibrillation, MI, stroke, sepsis, sternal wound infection, or the need for mediastinal reexploration between groups in the diabetic patients (table 6).

Discussion

Although obesity is well known to be a major risk factor for cardiovascular disease, many studies have failed to demonstrate that obesity is independently associated with an increased risk of cardiovascular morbidity and mortality in nondiabetic patients undergoing CABG surgery.[12,30,31] Consistent with previous reports, we now demonstrate that obesity in nondiabetic patients undergoing CABG surgery is not independently associated with an increased risk of death, MI, arrhythmias, or stroke.[12,31] However, in contrast to nondiabetic patients, morbid obesity was independently associated with an increased risk of adverse postoperative outcomes in diabetic patients, even after controlling for preoperative demographics, risk factors, medications, and intraoperative risk factors. Adverse outcomes independently associated with morbid obesity in diabetic patients included respiratory failure, atrial fibrillation, atrial flutter, ventric-

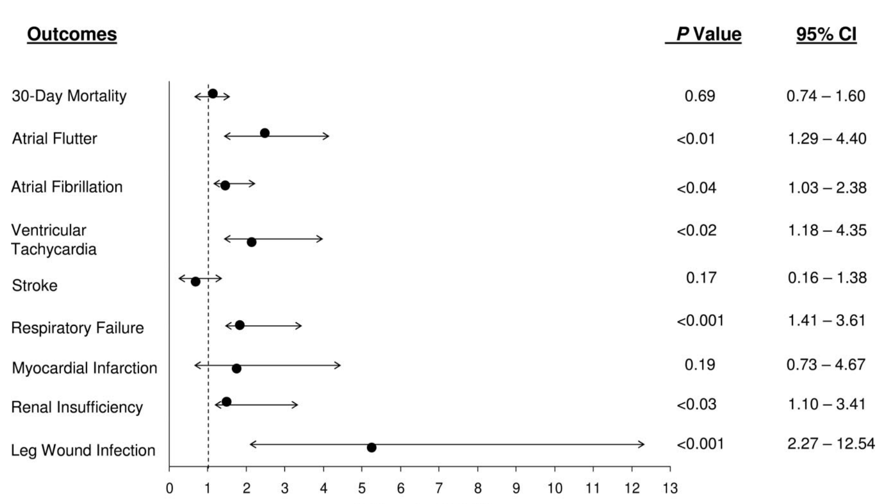

Fig. 1. Multivariate analysis of adverse postoperative outcomes independently associated with morbid obesity in diabetic patients undergoing primary coronary artery bypass graft surgery. CI = confidence interval.

ular tachycardia, renal insufficiency, and leg wound infection. Together, these data thus suggest that obesity in the context of diabetes confers an increased risk of worsened postoperative outcomes in patients undergoing CABG surgery.

Obesity and diabetes are key features of metabolic syndrome, which in turn is associated with increased systemic inflammation, thrombogenicity, and endothelial dysfunction.[3–6,40] Increasing evidence suggests that metabolic syndrome markedly increases the risk of cardiovascular events in ambulatory patient poulations.[41] Therefore, patients with metabolic syndrome might also be at greater risk of development of adverse postoperative outcomes compared with normal-weight or obese, nondiabetic patients. Supporting this hypothesis is our observation that the incidence of adverse postoperative outcomes was significantly higher in obese, diabetic patients compared with normal-weight or obese, nondiabetic patients. Further, obesity in diabetic but not in nondiabetic patients was independently associated with worsened postoperative outcomes. Therefore, the interaction between diabetes and obesity may significantly increase perioperative risk.

Previous studies examining the impact of obesity on adverse postoperative outcomes after cardiac surgery have yielded conflicting results. Although several studies have suggested that obesity is associated with an increased risk of postoperative mortality,[32–34,36] MI,[12] respiratory failure,[35] and atrial arrhythmias,[12,13,15,21] other investigations have failed to confirm these findings.[25–31] However, none of these previous studies specifically investigated the impact of obesity in diabetic *versus* nondiabetic patients. In our case series, obesity was not independently associated with an increased of risk of any adverse postoperative outcome in nondiabetic patients. In contrast, obesity was independently associated with an increased risk of respiratory failure, atrial fibrillation, atrial flutter, ventricular tachycardia, renal insufficiency, and leg wound infection in diabetic patients. Importantly, obesity was not independently associated with an increased risk of 30-day mortality, stroke, MI, sepsis, or sternal wound infection in diabetic patients. Also consistent with previous reports is our observation that the incidence of mediastinal reexploration was significantly lower in morbidly obese compared with normal-weight, nondiabetic patients.[30,31] However, these data cannot be interpreted to mean that obesity confers a reduced bleeding risk after CABG surgery, because chest tube output was not measured in our study, and no significant difference in the mediastinal reexploration rate was observed in morbidly obese compared with normal-weight, diabetic patients. Nonetheless, Birkmeyer *et al.*[30] previously reported in a series of 11,101 patients that obesity was independently associated with a decreased risk of postoperative bleeding after CABG surgery.

Multiple previous studies have linked obesity to an increased risk of wound infection.[12–14,15,16,17,20–24,30,31] For example, Prasad *et al.*[12] reported a deep sternal wound infection incidence of 9.2% in obese patients *versus* 2.8% in nonobese patients. Although obesity was not independently associated with an increased risk of sternal wound infection in our case series, obesity was independently predictive of an increased risk of leg wound infection in diabetic patients. One possible explanation as to why obesity in the nondiabetic patients was not predictive of an increased risk of postoperative wound infection is that the observed incidence of sternal and leg wound infection in our case serious was lower than that in previous reports.

Although this retrospective cohort study extends the results of previous studies by suggesting that obesity in the setting of diabetes is an independent risk factor for postoperative morbidity after CABG surgery, the current study is not without limitations. First, patient enrollment in our study was neither prospective nor randomized. Despite careful use of logistic regression models to adjust for potential confounders that may affect postoperative outcomes, immeasurable factors may still exist. Second, the relatively low number of morbidly obese patients in our case series may have limited our ability to detect independent, significant associations between obesity and low-frequency, adverse outcomes such as postoperative mortality. Of the three previous clinical studies reporting obesity as an independent risk factor for postoperative mortality after CABG surgery, two had subject enrollments exceeding 300,000 patients.[33,36] It was also because of these same power limitations that we were unable to determine whether obesity is an independent predictor of adverse postoperative outcomes in insulin-dependent *versus* non–insulin-dependent patients. Further research using appropriately designed prospective trials is therefore necessary to evaluate the impact of obesity on surgical outcomes in these subpopulations. Data obtained from such studies may improve perioperative risk stratification and resource utilization.

In conclusion, obesity seems to confer a greater risk of postoperative morbidity after primary CABG surgery in diabetic compared with nondiabetic patients.

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