Hyperglycemia and Its Association with Early Post-Operative Bariatric Surgery Outcomes

Au, C.; Schroer, J.;Xu, J.; Todd, J. ; Tomczyszyn, M.; Ali, A.; Sherman, V.; Tariq, N.
Houston Methodist Hospital, Houston, TX

Background/Introduction

- Previous studies have not found an association between elevated preoperative glycosylated hemoglobin (HgbA1c) and early postoperative complications following bariatric surgery. [1-3]
- Several studies have found that early postoperative hyperglycemia is associated with an increased risk of postoperative complications, but this association as it pertains to bariatric surgery has yet to be investigated. [4-5]
- In this study, we examine the association between early postoperative hyperglycemia and complications following bariatric surgery.

Methods

- Single center retrospective review between 2016 and 2024
- 6,914 patients who underwent laparoscopic sleeve gastrectomy and laparoscopic Roux-en-Y gastric bypass
- Two separate comparison groups defined by HgbA1c cut off
  - Group A (HgbA1C ≤ 8% vs HgbA1c > 8%)
  - Group B (HgbA1C ≤ 10% vs HgbA1c > 10%)
- Two separate comparison groups defined by different postoperative glucose cut off
  - Cohort A (average postoperative glucose ≤ 140 vs > 140)
  - Cohort B (average postoperative glucose ≤ 180 vs > 180)
- Propensity score matching (PSM) was used
- Individual postoperative outcomes were obtained using a conditional logistic regression model for binary variables
- Length of stay was assessed using a Poisson regression model.

Data Results

Table 1: Group A- outcomes by HbA1c≤8 vs. HbA1c>8 after PSM

	Total N=1,521	HbA1c≤8 N=1,138	HbA1c>8 N=383	p-value
Acute Renal Failure	4 (0.26)	4 (0.35)	0 (0.00)	0.456
Bowel obstruction	8 (0.53)	6 (0.53)	2 (0.52)	0.859
Cardiac Arrest	2 (0.13)	0 (0.00)	2 (0.52)	0.081
DVT	9 (0.59)	6 (0.53)	3 (0.78)	0.566
Deep Incisional SSI	1 (0.07)	0 (0.00)	1 (0.26)	0.180
Extraluminal intraabdominal bleeding	0 (0.00)	0 (0.00)	0 (0.00)	
Gastro tract bleed	5 (0.33)	3 (0.26)	2 (0.52)	0.448
Myocardial infarction	2 (0.13)	2 (0.18)	0 (0.00)	0.736
On Ventilator	5 (0.33)	2 (0.18)	3 (0.78)	0.091
Organ SSI	9 (0.59)	7 (0.62)	2 (0.52)	0.848
Pneumonia	8 (0.53)	4 (0.35)	4 (1.04)	0.107
Pulmonary Embolism	1 (0.07)	1 (0.09)	0 (0.00)	0.994
Renal Insufficiency	5 (0.33)	4 (0.35)	1 (0.26)	0.797
Sepsis	5 (0.33)	5 (0.44)	0 (0.00)	0.374
Septic Shock	3 (0.20)	3 (0.26)	0 (0.00)	0.570
StrokeCVA	0 (0.00)	0 (0.00)	0 (0.00)	
Superficial Incisional SSI	1 (0.07)	1 (0.09)	0 (0.00)	0.994
Transfusions	35 (2.30)	25 (2.20)	10 (2.61)	0.623
Unplanned admission	20 (1.31)	15 (1.32)	5 (1.31)	1.0
Unplanned intubation	7 (0.46)	3 (0.26)	4 (1.04)	0.070
Urinary Tract Infection	11 (0.72)	8 (0.70)	3 (0.78)	0.862
Wound disruption	1 (0.07)	0 (0.00)	1 (0.26)	0.18
Emergency Case	1 (0.07)	0 (0.00)	1 (0.26)	0.18
EmergencyDepartmentEDVisits1	111 (7.30)	80 (7.03)	31 (8.09)	0.484
30 day mortality	1 (0.07)	0 (0.00)	1 (0.26)	0.18
Readmission within 30 days	20 (1.31)	13 (1.14)	7 (1.83)	0.298
Reoperation within 30 days of Operation	5 (0.33)	1 (0.09)	4 (1.04)	**0.026**
Intervention within 30 days of Operation	5 (0.33)	3 (0.26)	2 (0.52)	0.417
Length of Stay	1.79±3.84	1.72±3.81	2.00±3.94	0.052
Prolonged>3 days	88 (5.79)	55 (4.84)	33 (8.62)	**0.006**
Prolonged>5 days	30 (1.97)	18 (1.58)	12 (3.13)	0.063
Glucose after surgery	151.85±40.24	140.72±32.53	187.80±41.78	**<0.001**

Table 2: Group B- outcomes by HbA1c≤10 vs. HbA1c>10 after PSM

	Total N=424	HbA1c≤10 N=317	HbA1c>10 N=107	p-value
Acute Renal Failure	0 (0.00)	0 (0.00)	0 (0.00)	
Bowel obstruction	2 (0.47)	2 (0.63)	0 (0.00)	0.708
Cardiac Arrest	0 (0.00)	0 (0.00)	0 (0.00)	
DVT	2 (0.47)	2 (0.63)	0 (0.00)	0.472
Deep Incisional SSI	1 (0.24)	0 (0.00)	1 (0.93)	0.327
Extraluminal intraabdominal bleeding	0 (0.00)	0 (0.00)	0 (0.00)	
Gastro tract bleed	1 (0.24)	1 (0.32)	0 (0.00)	0.713
Myocardial infarction	2 (0.47)	2 (0.63)	0 (0.00)	0.472
On Ventilator	0 (0.00)	0 (0.00)	0 (0.00)	
Organ SSI	2 (0.47)	2 (0.63)	0 (0.00)	0.472
Pneumonia	2 (0.47)	1 (0.32)	1 (0.93)	0.172
Pulmonary Embolism	0 (0.00)	0 (0.00)	0 (0.00)	
Renal Insufficiency	1 (0.24)	1 (0.32)	0 (0.00)	0.713
Sepsis	0 (0.00)	0 (0.00)	0 (0.00)	
Septic Shock	1 (0.24)	1 (0.32)	0 (0.00)	0.713
StrokeCVA	0 (0.00)	0 (0.00)	0 (0.00)	
Superficial Incisional SSI	0 (0.00)	0 (0.00)	0 (0.00)	
Transfusions	5 (1.18)	4 (1.26)	1 (0.93)	0.365
Unplanned admission	4 (0.94)	3 (0.95)	1 (0.93)	0.782
Unplanned intubation	0 (0.00)	0 (0.00)	0 (0.00)	
Urinary Tract Infection	3 (0.71)	3 (0.95)	0 (0.00)	0.385
Wound disruption	0 (0.00)	0 (0.00)	0 (0.00)	
Emergency Case	0 (0.00)	0 (0.00)	0 (0.00)	
EmergencyDepartmentEDVisits1	30 (7.08)	21 (6.62)	9 (8.41)	0.509
30 day mortality	0 (0.00)	0 (0.00)	0 (0.00)	
Readmission within 30 days	6 (1.42)	6 (1.89)	0 (0.00)	0.308
Reoperation within 30 days of Operation	0 (0.24)	0 (0.00)	0 (0.00)	
Intervention within 30 days of Operation	0 (0.00)	0 (0.00)	0 (0.00)	
Length of Stay	1.53±1.16	1.53±1.23	1.50±0.96	0.811
Prolonged>3 days	21 (4.95)	15 (4.73)	6 (5.61)	0.706
Prolonged>5 days	5 (1.18)	5 (1.58)	0 (0.00)	0.369
Glucose after surgery	161.78±45.41	150.00±38.90	198.84±44.70	**<0.001**

Table 3: Cohort A- outcomes by post glucose (≤140 vs. >140) after PSM

	Total N=2,436	Glucose≤140 N=1,218	Glucose>140 N=1,218	p-value
Acute Renal Failure	4 (0.16)	3 (0.25)	1 (0.08)	0.341
Bowel obstruction	10 (0.41)	5 (0.41)	5 (0.41)	1.00
Cardiac Arrest	1 (0.04)	0 (0.00)	1 (0.08)	0.501
DVT	11 (0.45)	6 (0.49)	5 (0.41)	0.763
Deep Incisional SSI	2 (0.08)	1 (0.08)	1 (0.08)	1.00
Extraluminal intraabdominal bleeding	0 (0.00)	0 (0.00)	0 (0.00)	
Gastro tract bleed	10 (0.41)	2 (0.16)	8 (0.66)	0.08
Myocardial infarction	4 (0.16)	2 (0.16)	2 (0.16)	1.00
On Ventilator	5 (0.21)	3 (0.25)	2 (0.16)	0.657
Organ SSI	12 (0.49)	5 (0.41)	7 (0.57)	0.566
Pneumonia	12 (0.49)	5 (0.41)	7 (0.57)	0.566
Pulmonary Embolism	2 (0.08)	0 (0.00)	2 (0.16)	0.299
Renal Insufficiency	3 (0.12)	1 (0.08)	2 (0.16)	0.571
Sepsis	4 (0.16)	2 (0.16)	2 (0.16)	1.00
Septic Shock	4 (0.16)	3 (0.25)	1 (0.08)	0.341
StrokeCVA	1 (0.04)	0 (0.00)	1 (0.08)	0.501
Superficial Incisional SSI	6 (0.25)	4 (0.33)	2 (0.16)	0.423
Transfusions	25 (1.03)	13 (1.07)	12 (0.99)	0.842
Unplanned admission	30 (1.23)	14 (1.15)	16 (1.31)	0.715
Unplanned intubation	7 (0.29)	5 (0.41)	2 (0.16)	0.273
Urinary Tract Infection	13 (0.53)	6 (0.49)	7 (0.57)	0.782
Wound disruption	1 (0.04)	0 (0.00)	1 (0.08)	0.501
Emergency Case	0 (0.00)	0 (0.00)	0 (0.00)	
Emergency Department ED Visits	183 (7.51)	102 (8.37)	81 (6.65)	0.111
30 day mortality	1 (0.04)	0 (0.00)	1 (0.08)	0.501
Readmission within 30 days	10 (0.41)	4 (0.33)	6 (0.49)	0.53
Reoperation within 30 days of Operation	3 (0.12)	0 (0.00)	3 (0.25)	0.198
Intervention within 30 days of Operation	4 (0.16)	1 (0.08)	3 (0.25)	0.341
Length of Stay	1.52±2.52	1.56±2.50	1.49±2.55	0.442
Prolonged>3 days	84 (3.45)	45 (3.70)	39 (3.20)	0.497
Prolonged>5 days	30 (1.23)	15 (1.23)	15 (1.23)	1.00

Table 4: Cohort B outcomes by post glucose (≤180 vs. >180) after PSM

	Total N=1,263	Glucose≤180 N=944	Glucose>180 N=319	p-value
Acute Renal Failure	2 (0.16)	2 (0.21)	0 (0.00)	0.734
Bowel obstruction	6 (0.48)	5 (0.53)	1 (0.31)	0.814
Cardiac Arrest	2 (0.16)	0 (0.00)	2 (0.63)	0.082
DVT	7 (0.55)	5 (0.53)	2 (0.63)	1.00
Deep Incisional SSI	2 (0.16)	1 (0.11)	1 (0.31)	0.348
Extraluminal intraabdominal bleeding	0 (0.00)	0 (0.00)	0 (0.00)	
Gastro tract bleed	8 (0.63)	6 (0.64)	2 (0.63)	0.842
Myocardial infarction	1 (0.08)	1 (0.11)	0 (0.00)	0.992
On Ventilator	2 (0.16)	0 (0.00)	2 (0.63)	0.082
Organ SSI	6 (0.48)	5 (0.53)	1 (0.31)	0.641
Other	0 (0.00)	0 (0.00)		
Pneumonia	5 (0.40)	3 (0.32)	2 (0.63)	0.684
Pulmonary Embolism	3 (0.24)	2 (0.21)	1 (0.31)	0.579
Renal Insufficiency	1 (0.08)	1 (0.11)	0 (0.00)	0.992
Sepsis	5 (0.40)	5 (0.53)	0 (0.00)	0.372
Septic Shock	2 (0.16)	2 (0.21)	0 (0.00)	0.734
Stroke/CVA	0 (0.00)	0 (0.00)	0 (0.00)	
Superficial Incisional SSI	5 (0.40)	4 (0.42)	1 (0.31)	0.797
Transfusions	15 (1.19)	13 (1.38)	2 (0.63)	0.298
Unplanned admission	18 (1.43)	13 (1.38)	5 (1.57)	0.893
Unplanned intubation	6 (0.48)	3 (0.32)	3 (0.94)	0.266
Urinary Tract Infection	9 (0.71)	8 (0.85)	1 (0.31)	0.355
Wound disruption	0 (0.00)	0 (0.00)	0 (0.00)	
Emergency Case	0 (0.00)	0 (0.00)	0 (0.00)	
Emergency Department ED Visits	83 (6.57)	61 (6.46)	22 (6.90)	0.793
30 day mortality	1 (0.08)	0 (0.00)	1 (0.31)	0.181
Readmission within 30 days	5 (0.40)	4 (0.42)	1 (0.31)	0.797
Reoperation within 30 days of Operation	2 (0.16)	2 (0.21)	0 (0.00)	0.734
Intervention within 30 days of Operation	2 (0.16)	1 (0.11)	1 (0.31)	0.437
Length of Stay	1.61±2.82	1.57±2.26	1.70±4.05	0.592
Prolonged>3 days	52 (4.12)	38 (4.03)	14 (4.39)	0.831
Prolonged>5 days	17 (1.35)	14 (1.48)	3 (0.94)	0.388

Results

- After PSM, demographics and comorbidities were matched in both comparison groups
- No significant association between early postoperative hyperglycemia and major complications including post-operative bleeding, anastomotic leak, or surgical site infection in cohort A and cohort B
- No increased risk of prolonged length of stay, readmission, reoperation, or early mortality in cohort A and B.
- Significant association between elevated preoperative HgbA1c >8% in group A and need for reoperation (p=0.02), as well as prolonged length of stay >3 days (p=0.006). This association was not seen when Hgb A1c cut off was higher in group B

Conclusion

To our knowledge, early postoperative hyperglycemia and its relationship with postoperative outcomes after bariatric surgery has not been previously studied. Based on this study, early postoperative hyperglycemia is not associated with an increased risk of bariatric surgery complications. However, elevated preoperative HgbA1c may be associated with prolonged length of stay and need for reoperation.

Zia M, Hoof T, Xu JS, Davis G, Ali A, Sherman V, Tariq N. Elevated Hb A1C level and revisional bariatric surgery complications. Surg Obes Relat Dis. 2024 Sep;20(9):864-871. doi: 10.1016/j.soard.2024.03.023. Epub 2024 Apr 8. PMID: 38749781.
Basishvili G, Yang J, Nie L, Docimo S Jr, Pryor AD, Spaniolas K. HbA1C is not directly associated with complications of bariatric surgery. Surg Obes Relat Dis. 2021 Feb;17(2):271-275. doi: 10.1016/j.soard.2020.10.009. Epub 2020 Oct 14. PMID: 33243668.
Shah K, Gögenur I, Gislason H. High preoperative HbA1c does not affect early or late complication rates after bariatric surgery. Surg Endosc. 2023 Jul;37(7):5313-5319. doi: 10.1007/s00464-023-10009-w. Epub 2023 Mar 29. PMID: 36991264.
Chen JY, Nassereldine H, Cook SB, Thornblade LW, Dellinger EP, Flum DR. Paradoxical Association of Hyperglycemia and Surgical Complications Among Patients With and Without Diabetes. *JAMA Surg*. 2022;157(9):765–770. doi:10.1001/jamasurg.2021.5561
Kotagal M, Symons RG, Hirsch IB, Umpierrez GE, Dellinger EP, Farrokhi ET, Flum DR; SCOAP-CERTAIN Collaborative. Perioperative hyperglycemia and risk of adverse events among patients with and without diabetes. Ann Surg. 2015 Jan;261(1):97-103. doi: 10.1097/SLA.0000000000000688. PMID: 25133932; PMCID: PMC4208939.