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Perioperative Glycemic and Hemodynamic Changes in Diabetic Patients Undergoing Orthopedic Surgery: A Prospective Observational Study in Iraq

Hayman Mohammed Saeed Rashid

Anesthesia Department/ Al-Qalam University College/Kirkuk/ Iraq.

Lecturer/ BSN, MSc., Ph.D., hemenjaff@ymail.com, hemen.rashid@alqalam.edu.iq

Orchid ID: https://orcid.org/0000-0001-7311-4250

ResearchGate: https://www.researchgate.net/profile/Hayman-Rashid?ev=hdr_xprf

Link of Google Scholar ID:

https://scholar.google.com/citations?user=PiJkfjwAAAAJ&hl=en

Phone No: 009647507933535, Scopus ID:57577239400

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Abstract

Background:

Perioperative hyperglycemia and blood pressure instability are common among patients with diabetes mellitus undergoing orthopedic surgery and are associated with increased postoperative morbidity. Anesthetic techniques and surgical stress responses may significantly influence metabolic and hemodynamic parameters. This study aimed to evaluate perioperative changes in blood glucose and blood pressure among diabetic patients undergoing orthopedic procedures.

Methods:

A prospective observational hospital-based study was conducted between November 2024 and April 2025, including 184 diabetic patients undergoing orthopedic surgery. Blood glucose and blood pressure were measured preoperatively and postoperatively. Sociodemographic, clinical, and operative variables were recorded. Associations between preoperative and postoperative parameters were analyzed using chi-square tests, with statistical significance set at $p \leq 0.05$.

Results:

A significant association was observed between preoperative and postoperative glucose levels ($p < 0.001$). Notably, 50% of patients with normal preoperative glucose developed postoperative hyperglycemia. Patients with preoperative hyperglycemia remained hyperglycemic postoperatively (100%). Significant associations were also found between preoperative and postoperative systolic and diastolic blood pressure ($p \leq 0.001$), with pre-existing hypertension strongly predicting postoperative hypertension. Most surgeries were elective and of moderate complexity.

Conclusion:

Orthopedic surgery in diabetic patients is associated with significant perioperative glycemic and blood pressure fluctuations. These findings emphasize the need for strict perioperative metabolic and hemodynamic monitoring to reduce postoperative complications. Further analytical studies are recommended to determine independent predictors of adverse outcomes.

Keywords: Diabetes mellitus; Orthopedic surgery; Perioperative hyperglycemia; Blood pressure; Anesthesia

Introduction

The proportion of orthopedic surgeries performed on older adults continues to rise, coinciding with a significant increase in age-related comorbidities such as diabetes and hypertension. This demographic shift presents notable clinical challenges, as surgical patients with diabetes and concurrent hyperglycemia demonstrate substantially higher risks of postoperative complications compared to their normoglycemic counterparts [1]. Hypertension has been found to be a risk factor for 30-day readmission in both total knee and hip arthroplasty [2]. In hip arthroplasty, hypertensive patients had a higher risk of prolonged wound discharge [1]. In knee arthroplasty, hypertension was a risk factor for unplanned reintubation, urinary tract infection, postoperative transfusion, myocardial infarction, and extended length of hospital stay [3]. Hyperglycemia, or diabetes mellitus (DM), occurs when blood glucose levels exceed 125 mg/dL while fasting or rise above 180 mg/dL two hours after eating. A person is considered prediabetic if their fasting glucose falls between 100 and 125 mg/dL, while levels above 125 mg/dL indicate diabetes [1]. According to the CDC (2024)[4], around 38 million adults in the U.S. have diabetes, yet 1 in 5 are unaware of their condition. Diabetes is the eighth leading cause of death and is responsible for most cases of kidney failure, lower-limb amputations, and adult blindness. Type 2 diabetes makes up 90-95% of all cases, while Type 1 accounts for the remaining 5-10%. Over the past two decades, diabetes diagnoses have more than doubled [2]. Patients with DM are more prone to undergo surgical interventions; ~25% of patients with DM will require surgery [3]. Patients with diabetes are also more likely to need surgery, about 25% will undergo a surgical procedure at some point. Surgery and anesthesia trigger a stress response, releasing hormones like adrenaline, cortisol, and glucagon, which spike blood sugar and increase insulin resistance. In vulnerable patients, this can lead to dangerous hyperglycemia. High blood sugar weakens immune function, raising the risk of infections and even death [5]. Neuraxial anesthesia (such as epidural or spinal blocks) may help by reducing the body's stress response, including hyperglycemia [6]. However, studies show that even non-diabetic patients can experience concerning blood sugar spikes after major surgeries like joint replacements. Research by Jämsen et al. found that up to 40% of orthopedic patients had glucose levels above 7.8 mmol/L (140 mg/dL), with a quarter reaching severe hyperglycemia (≥180 mg/dL). Without close monitoring, these dangerous spikes can go undetected [6]. Worldwide studies have revealed opposing results in orthopedic patients linked with hyperglycemia [4-6]. The objective of this study was to characterize perioperative glycemic and hemodynamic variations in diabetic patients undergoing orthopedic surgery and to determine the factors influencing these variations in a tertiary hospital in Kirkuk, Iraq.

Methods and materials

Study design and setting: This observational prospective hospital-based study was used to assess the effect of anesthesia on patients with or without DM and blood pressure and was conducted at Kirkuk General Hospital in Kirkuk City, Iraq. The study was conducted between November 20th, 2024 and April 20th 2025.

Data collection: The data was collected by direct interview. A specially designed questionnaire was prepared by the researcher for the study, targeting relevant subjects to encompass all possible variables addressing the research objectives. The questionnaire was structured to collect data on key variables, including socio-demographic profiles (Age, height, weight and Sex, type of operation), Blood pressure and glucose levels, type of surgery, smoker/alcohol status, addicted, family inherited disease, fasting hours, taking insulin pre-op, difficulty of the process, type of anesthesia technique, level of anxiety and aggression, wound class, DM type, clinical outcome, time of surgery, complications and the urgency for surgery. A pilot study was conducted to refine the questionnaire, after which the final draft was prepared.

The study population comprised individuals of all ages (male/female) who presented with a DM in orthopedic surgery during the study period. A total of 184 cases were identified and included in the study. Cases were selected based on the diagnosis of DM documented in the medical records and operation rooms.

Ethical Considerations

A written approval was obtained by the Kirkuk Directorate of Health for Kirkuk hospitals. Patient confidentiality was maintained, with data anonymized and used only for this research by direct interviewing with verbal ethical consent from each one.

2.6 Included criteria:

Only DM patients admitted for orthopedic surgery due to any acute causes to the operating room and the emergency department at Kirkuk hospitals for both males/females.

Statistical Analysis:

Descriptive statistics (mean, standard deviation for continuous variables; frequencies and percentages for categorical variables) were used to summarize the data. The association between the glucose level for DM in orthopedic surgery outcomes and potential risk factors (e.g., age, gender, type of surgery, clinical observations, and socioeconomic status) was analyzed using chi-square tests for categorical variables. Chi-Square (X^2) analysis was performed to identify the association between sociodemographic features and some variables, such as blood pressure and blood glucose before and after surgery. Variables were measured as statistically significant at $P \leq 0.05$.

Results

The study sample consisted of 184 participants, with the largest age group being individuals aged 60 or older (28.3%), while the smallest group was children aged 0-9 (3.3%). The gender distribution was nearly equal, with males slightly outnumbering females (51.1% vs. 48.9%). Education levels varied, with the majority having intermediate education (35.3%), and only one participant holding an MSc degree (0.5%). Most participants reported their family income as "enough" (84.8%), while very few (3.3%) felt it exceeded their needs. Alcohol consumption was rare (1.1%), and the majority were nonsmokers (59.2%), with current smokers making up the smallest group (10.9%). The details were described in Table 1.

Table 1: Assessment of Socio-Demographic Characteristics of the studied sample

Variable	Characteristics	No.(%)
Age group	≤ 9	6(3.3)
	10-19	18(9.8)
	20-29	21(11.4)
	30-39	35(19.0)
	40-49	29(15.8)
	50-59	23(12.5)
	60 ≥	52(28.3)
Sex	Male	94(51.1)
	Female	90(48.9)
Educational level	Illiterate	14(7.6)
	Primary	54(29.3)
	Intermediate	65(35.3)
	high school	19(10.3)
	Diploma	18(9.8)
	Bachelor	13(7.1)
	MSc ≥	1(0.5)
Family income	Not enough	22(12.0)
	Enough	156(84.8)
	Exceed need	6(3.3)
Alcohol consumption	Yes	2(1.1)
	No	182(98.9)
Smoking	Non-smoker	109(59.2)
	Ex-smoker	55(29.9)
	Smoker	20(10.9)
Total		184(100)

As showed in Table 2. Occupational data revealed that semi-skilled manual workers formed the largest group (54.9%), while associate professionals were the smallest (0.5%). Weight distribution showed that most participants were in the 70-79 kg range (41.3%), with very few weighing 90-99 kg (3.3%). Home ownership was common (60.9%), while alternative living arrangements were rare (2.7%). The majority were married (77.2%), with divorced and widowed individuals being the smallest groups (1.1% each). In terms of height, most participants were over 160 cm tall (78.8%), while the shortest group (129-139 cm) was minimal (2.2%). Family-inherited diseases were absent in 66.8% of cases, and addiction was uncommon (4.3%).

Table 2: Distribution of study sample (N=184) by some lifestyle characteristics.

Variable	Characteristics	No.(%)
Occupation	Unskilled manual	15(15)
	Skilled professional	47(25.5)
	semi-skilled manual	101(54.9)
	Skilled manual	20(10.9)
	Associate professional	1(0.5)
Weight in Kg	≤49	14(7.6)
	50-59	14(7.6)
	60-69	44(23.9)
	70-79	76(41.3)
	80-89	30(16.3)
	90≥	6(3.3)
Home ownership	Owned	112(60.9)
	Rented	57(31)
	Partial owned	10(5.4)
	Other	5(2.7)
Marital status	Single	38(20.7)
	Married	142(77.2)
	Divorced	2(1.1)
	Widow	2(1.1)
	100-119	3(1.6)
Height in cm	129-139	4(2.2)
	149-159	32(17.4)
	160≥	145(78.8)
Family inherited disease	Yes	61(33.2)
	No	123(66.8)
Addicted	Yes	8(4.3)
	No	176(95.7)
Total		184(100)

The most common surgeries were fractured limb fixation (13.6%) and joint replacement (10.9%), while rib fracture and congenital club foot surgeries were the rarest (0.5% each) (Table 3). Most patients had short hospital stays (74.5% stayed more than one day, but only 1.1% stayed 5-9 days). The majority of wounds were classified as clean (89.1%), with dirty wounds being extremely rare (0.5%). Most surgeries were performed during the day (81%) and were elective (90.8%). The difficulty level of procedures was mostly moderate (69.6%), with minor procedures being the least common (8.2%). Only 13.6% of patients took insulin pre-operatively. These findings suggest that the study primarily involved elective, daytime surgeries with clean wounds and moderate complexity, with very few high-risk or emergency cases.

Table 3: Operation-related information of the study sample.

Variable	Characteristics	No.(%)
Type of surgery	Diabetic foot (amputation)	15(8.2)
	Fractured limb (fixation)	25(13.6)
	Amputation (fracture, inflammation and clotting etc.	14(7.6)
	spine surgery	16(8.7)
	pediatric orthopedics	5(2.7)
	Foot and ankle surgery	20(10.9)
	shoulder surgery	20(10.9)
	Hip surgery	13(7.1)
	Knee replacement	15(8.2)
	Joint replacement	20(10.9)
	Sports injuries surgery	15(8.2)
	limb deformity	4(2.2)
	Rib fractured surgery	1(0.5)
	Congenital club foot	1(0.5)
Duration of stay in hospital in days	≤1	137(74.5)
	2-4days	45(24.5)
	5-9days	2(1.1)
Wound class	Clean	164()89.1
	Clean contaminated	13(7.1)
	Contaminated	6(3.3)
	Dirty	1(0.5)
Time of surgery	Day	149(81.0)
	Night	35(19.0)
Urgency of surgery	Urgent	17(9.2)
	Elective	167(90.8)
Difficulty of the process	Minor	15(8.2)
	Moderate	128(69.6)
	Major	41(22.3)
Taking insulin pre-op	Yes	25(13.6)
	No	159(86.4)
Total		184(100)

During surgery of the present study (Table 4), the most common systolic blood pressure (BP) range was below 120 mmHg (44%), while extreme hypertension (≥160 mmHg) was the least common (10.9%). Diastolic BP during surgery was mostly below 80 mmHg (53.3%), with the highest range (110-119 mmHg) being rare (3.3%). After surgery, systolic

BP was most frequently either below 120 mmHg (23.9%) or between 140-149 mmHg (23.9%), with severe hypertension (≥160 mmHg) occurring in only 3.8% of cases. Diastolic BP post-operation was most often below 80 mmHg (44.6%), while extreme cases (≥120 mmHg) were almost negligible (0.5%).

Table 4: Blood pressure level during and after the operation

Variable	Characteristics	No.(%)
BP during the operation, systolic BP	**≤119**	**81(44.0)**
	120-129	**25(13.6)**
	130-139	**8(4.3)**
	140-149	**27(14.7)**
	150-159	**23(12.5)**
	160≥	**20(10.9)**
BP level during the operation, diastolic BP	**≤79**	**98(53.3)**
	80-89	**26(14.1)**
	90-99	**47(25.5)**
	100-109	**7(3.8)**
	110≥	**6(3.3)**
BP level after the operation, systolic BP	**≤119**	**44(23.9)**
	120-129	**43(23.4)**
	130-139	**35(19.0)**
	140-149	**44(23.9)**
	150-159	**11(6.0)**
	160≥	**7(3.8)**
BP after the operation, diastolic BP	**≤79**	**82(44.6)**
	80-89	**64(34.8)**
	90-99	**25(13.6)**
	100-109	**12(6.5)**
	120≥	**1(0.5)**
Total		**184(100)**

Moderate anxiety and aggression were reported by half of the participants (50%), while extreme anxiety was rare (13%). The most common post-operative complication was pain (41.8%), whereas delirium was the least frequent (0.5%). Surgery duration varied, with most procedures lasting 110-129 minutes (28.8%), while very short (<30 minutes) or very long (≥190 minutes) surgeries were uncommon. Recovery time was fastest in 1-9 minutes for most patients (26.6%), with only 6.5% recovering in under a minute (Table 5).

Table 5: Distribution of the studied sample with some characteristics

Variable	Characteristics	No.(%)
Level of anxiety and aggression	Moderate	92(50.0)
	Relaxed	68(37.0)
	Super anxiety and aggression	24(13.0)
Complications related to operation	Bleeding	11(6.0)
	Vomiting	6(3.3)
	Pain	77(41.8)
	Delay recovery	17(9.2)
	Delirium	1(0.5)
	Other	72(39.1)
Time of operation in minutes	≤29	1(0.5)
	30-49min	10(5.4)
	50-69min	41(22.3)
	70-89min	13(7.1)
	90-109min	27(14.7)
	110-129min	53(28.8)
	130-149min	2(1.1)
	150-169min	9(4.9)
	170-189min	22(12.0)
	190≥	6(3.3)
Time of recovery (minutes)	≤1min	12(6.5)
	1-9min	49(26.6)
	10-19min	44(23.9)
	20≥min	35(19.0)
Total		184(100)

In the present study, a highly significant association ($p < 0.001$) was found between pre-operative and post-operative glucose levels. Patients with normal pre-operative glucose levels mostly developed hyperglycemia after surgery (50%), while those with pre-existing hyperglycemia remained hyperglycemic post-operation (100%). Hypoglycemia after surgery was most common in patients who already had low glucose levels before surgery (57.1%). These details were presented in Table 6.

In this study, as revealed in Table 7, for systolic BP, a significant association ($p \leq 0.001$) was observed, with pre-operative hypertension strongly linked to post-operative hypertension (48%). Interestingly, post-operative hypotension was most common in patients who had normal BP before surgery (35.3%). Diastolic BP also showed a significant association ($p \leq 0.001$), with pre-existing hypertension often leading to postoperative hypertension (20.7%), while hypotension after surgery was most frequent in those with pre-operative hypotension (43.8%).

Table 6: Association between blood glucose before and after surgery

Variables	Glucose level after operation				P-value
Glucose level before operation	Hypoglycemia	Normal	Hyperglycemia	Total	
	No.(%)	No.(%)	No.(%)	No.(%)	
Hypoglycemia	16(57.1)	11(39.3)	1(3.6)	28(100)	
Normal blood glucose	10(9.6)	42(40.4)	52(50.0)	104(100)	≤0.001
Hyperglycemia	0(0.0)	0(0.0)	52(100)	52(100)	
Total	26(14.1)	53(28.8)	105(57.1)	184(100)	

Table 7: Association between blood pressure before and after operation

Variables	Blood Pressure after the operation					P-value
Systolic BP before operation	Hypotension	Normal BP	Pre-hypertension	Hypertension	Total	
	No.(%)	No.(%)	No.(%)	No.(%)	No.(%)	
Hypotension	17(25)	22(32.4)	11(16.2)	18(26.5)	68(100)	
Normal BP	6(35.3)	2(11.8)	3(17.6)	6(35.3)	17(100)	≤0.001
Pre-hypertension	1(4.2)	5(20.8)	6(25.0)	12(50)	24(100)	
Hypertension	5(6.7)	16(21.3)	18(24)	36(48)	75(100)	
Total	29(15.8)	45(24.5)	38(20.7)	72(39.1)	184(100)	
Diastolic BP before op.	Hypotension	Normal BP	Hypertension	Total		
Hypotension	32(43.8)	38(52.1)	3(4.1)	73(100)		
Normal BP	16(31.4)	23(45.1)	12(23.5)	51(100)		≤0.001
Hypertension	13(21.7)	85(46.2)	38(20.7)	60(100)		
Total	61(33.2)	85(46.2)	38(20.7)	184(100)		

Discussion

The findings of this study provide valuable insights into the socio-demographic, clinical, and perioperative characteristics of the study population, as well as the associations between pre-operative and post-operative physiological parameters. Below, we discuss these results in the context of existing literature, highlighting agreements and disagreements with previous studies.

A study sample primarily consisted of older adults, a demographic that is projected to increase significantly in the coming decades. According to data from the United States Census Bureau, the global population aged 65 and above is expected to rise to 1.6 billion by 2050 [7]. However, orthogeriatric patients present unique clinical challenges that extend beyond standard orthopedic care. These individuals often exhibit complex health profiles, including multiple comorbidities, polypharmacy, frailty, Osteosarcopenia, malnutrition, reduced mobility, cognitive impairments, and other geriatric syndromes, all of which contribute to elevated risks of complications and mortality [8]. To address these multifaceted needs, the Comprehensive Geriatric Assessment (CGA) serves as an interdisciplinary diagnostic approach, evaluating medical, psychosocial, and functional capacities in frail elderly patients. This process facilitates the development of tailored, integrated care strategies aimed at optimizing health outcomes in ageing populations [7].

The present study results demonstrated a statistically significant association between blood glucose levels before surgery and those after surgery (P-value $\leq$ 0.001). In agreement with these results, a study conducted by Liu J and Yang (2020)[9] at Hospital of Baotou Medical College (Baotou, China) between 2017 and 2018, which illustrated that levels of 110 patients gradually increased and were significantly higher than those before the patients were anesthetized. Another study between 2023 and 2024 (Alzubaid et al., 2025)[10] for 40 pregnant women scheduled for the cesarean section at Babylon Hospital and Al Sadiq teaching hospital significant proportional increase in mean blood glucose concentrations with glucose-check timing (5 minutes before induction, 5 minutes after induction, 5 minutes before the end of surgery, and 30 minutes after the end of surgery), and this increase is significantly much greater in general anesthesia than it is in spinal anesthesia.

Finally, another study by AL-Harire in 2025 [11] confirmed our results. It concluded that general anesthesia was associated with a greater increase in blood glucose concentration compared to spinal anesthesia in non-diabetic patients undergoing elective cesarean sections. This suggests that spinal anesthesia may be a preferable option for better perioperative glucose control, potentially reducing the risk of complications related to hyperglycemia. Further research with larger sample sizes is recommended to validate these findings.

The present study finding showed a statistically significant association (P-value$\leq$0.001) between blood pressure before and after surgery (Systolic and diastolic separately), in agreement with our results a study was conducted to discover common causes of hypertension during the perioperative period (pre, intra, and post-operation) in 174 clients who underwent noncardiac operations at University Health Network (UHN) hospitals, Canada, between 2015 and 2020 [12], Poor control of hypertension showed both within-subject statistical significance for systolic and between-subject statistical relevance to diastolic blood pressure.

A retrospective observational study (2017–2021) involving 57,389 cases revealed a U-shaped relationship between systolic (SBP) and diastolic blood pressure (DBP) measurements and postoperative adverse events. The lowest risk occurred at thresholds of 143 mmHg for SBP and 86 mmHg for DBP, with elevated risks observed both above and below these values. The most pronounced associations were observed at the extremes: for SBP, the highest risk occurred at 173 mmHg (adjusted OR, 1.212; 95% CI, 1.021–1.439; $P = 0.028$) and 93 mmHg (adjusted OR, 1.339; 95% CI, 1.211-1.479; $P < 0.001$) compared to the reference (143 mmHg). Similarly, for DBP, peak risks were observed at 106 mmHg (adjusted OR, 1.294; 95% CI, 1.003–1.671; $P = 0.048$) and 46 mmHg (adjusted OR, 1.399; 95% CI, 1.244-1.558; $P < 0.001$) relative to the 86 mmHg [13]. Finally, a cohort study of primary care data from the UK Clinical Practice Research Datalink (2004-2013) by Venkatesan et al. (2017)[14], 251,567 adults and 589 deaths. Statistically significant risk thresholds started at a preoperative systolic pressure of 119 mm Hg (adjusted OR 1.02 [95% confidence interval (CI) 1.01–1.02]) compared with the reference (120 mm Hg) and diastolic pressure of 63 mm Hg [OR 1.24 (95% CI 1.03-1.49)] compared with the reference (80 mm Hg). As BP decreased, the OR of mortality risk increased. Subgroup analysis demonstrated that the risk associated with low BP was confined to the elderly. Adjusted analyses identified that diastolic hypertension was associated with increased postoperative mortality in the whole cohort.

These findings may be related to pathophysiological factors [16,17] of the hyperglycemia itself, Stress response, Cortisol, Catecholamines, and Insulin resistance. It would seem that the association between insulin treatment and heart disease is multifaceted and understated, with the assistance of insulin treatment through stress, high blood glucose conditions in myocardial infarction, outstandingly controversial. Though countless agreement of study has been conducted to explain glucose-heart connections, there remain a lot of questions to be answered [18].

Limitations

This study has several limitations that should be considered when interpreting the findings. First, it was conducted in a single tertiary hospital, which may limit the generalizability of the results to other healthcare settings or populations. Second, although the study was prospective, it was observational in nature; therefore, causal relationships between anesthesia-related factors and perioperative metabolic or hemodynamic changes cannot be definitively established. Third, long-term postoperative outcomes were not assessed, as measurements were limited to the immediate perioperative period. Additionally, glycated hemoglobin (HbA1c) levels were not routinely available for all participants, which restricted the ability to evaluate the influence of baseline glycemic control on postoperative hyperglycemia. Finally, multivariate regression analysis was not performed to adjust for potential confounding variables, which may have influenced the observed association.

Conclusions

This study demonstrates a significant association between preoperative and postoperative blood glucose and blood pressure levels among diabetic patients undergoing orthopedic surgery. The substantial occurrence of postoperative hyperglycemia, even in patients with normal baseline glucose levels, suggests that surgical stress and anesthesia may play a critical role in perioperative metabolic dysregulation. These findings reinforce the need for vigilant perioperative monitoring and individualized management strategies to optimize patient safety and surgical outcomes.

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