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Continuous insulin infusion versus sliding scale for perioperative glycemic control in diabetic patients undergoing elective hip arthroplasty

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Abstract
Background: The incidence of diabetes mellitus (DM) in patients undergoing total hip arthroplasty (THA) and total knee arthroplasty (TKA) is as high as 52%. The aim of this work was to compare between continuous insulin infusion method versus sliding scale method in glycemic control and decreasing the rate of postoperative wound infection in diabetic patients undergoing elective hip arthroplasty.
Methods: This prospective randomized controlled trial was carried out on 40 patients aged from 35 to 70 years old, both sexes, diagnosed with type II diabetes underwent American society of anesthesiologists (ASA) II or III who subjected to elective hip arthroplasty. Subjects were allocated into two equal groups. Group C (control group): subjected to sliding scale and Group P (protocol group): subjected to insulin infusion in a concentration of 100U insulin on 100mL of normal saline and if there was no response to initial dose of insulin or still measurements were higher than preset range, doses were doubled.
Results: There was significant decrease in the random blood sugar measurements in group P who were subjected to insulin infusion than group C who subjected to sliding insulin scale at 1, 2, 3 and 4 hours follow up during surgery ($p< 0.001$). As regard intraoperative heart rate (HR), mean arterial pressure (MAP), follow-up, there was non-statistically significant difference between both studied groups regarding subsequent HR measurements prior surgery start (baseline), and at 15, 30, 45.60, 90, 120, 150, 180, 210 and 240 minutes. All measurements were slightly higher in group C, but the difference was not statistically significant ($p> 0.05$).

Keywords: Insulin infusion, glycemic control, DM, elective hip arthroplasty

Introduction
Currently, hip replacement surgery has the distinction of being the most efficacious orthopedic procedure on a global scale. The World Health Organization (WHO) designated it as the "operation of the century" because of its significant pain alleviation and effective mobilization capabilities [1, 2].
The prevalence of osteoarthritis (OA) and DM is on the rise, mostly due to the aging global population and the growing obesity epidemic. Consequently, there is a growing number of individuals who are affected by both disorders. Hyperglycemia directly contributes to the cartilage destruction observed in OA via oxidative stress, proinflammatory pathways, and acceleration of bone remodeling. This further reinforces the connections between these disorders [3].
The prevalence of DM in patients who undergo total hip arthroplasty (THA) and TKA might reach up to 52% [4]. Projections indicate that the number of initial THA procedures is projected to increase by 171% by the year 2030. Similarly, the number of revision THA procedures is likely to rise by 142% over the same period [5].
Peri-prosthetic joint infection (PJI) refers to an infection that affects both the joint prosthesis and the surrounding tissue. The occurrence of this condition is infrequent, with documented rates ranging from 0.25% to 2.0%. Nevertheless, this morbidity might have severe consequences since it may compromise the outcomes of the treatment and perhaps raise fatality rates. Presently, significant efforts have been made to enhance and refine the materials used in prostheses and the surgical techniques used in THA [6].

Sliding scale insulin fails to account for basal insulin requirements, dietary factors, individual traits, or insulin use history. Furthermore, it is a responsive method for managing increases in glucose levels, rather than a proactive approach aimed at preventing a hyperglycemic condition. The efficacy and safety of conventional sliding scale insulin have been widely questioned by specialists [7].

Controlling blood glucose levels during the whole perioperative phase of surgery is crucial for reducing the risk of complications and death. It is important to prevent the occurrence of hyperglycemia, hypoglycemia, and potentially significant fluctuations in blood glucose levels. According to the available research, a blood glucose level of 10.1 mmol/L is the point at which insulin should be started. The topic of normoglycemic hyperinsulinism is intriguing, however, it requires bigger multicenter randomized controlled research to accurately evaluate its potential significance [8].

The notion of administering glucose and insulin while maintaining normal blood sugar levels, known as the 'Glucose and Insulin administration while maintaining normoglycemia' (GIN), was developed in cardiac surgery in 2004. Unlike standard insulin sliding scales, this approach adjusts the pace of glucose infusion instead of altering the insulin dosage, which remains constant. We maintained blood glucose levels between 3.5 and 6.1 mmol L−1 by using a preemptive insulin infusion, followed by the delivery of glucose at a variable pace. In later investigations, we have shown that GIN has cardio-protective and anti-inflammatory benefits in patients undergoing cardiac operations [9].

The objective of this study was to evaluate the efficacy of continuous insulin infusion technique with the sliding scale approach in managing blood sugar levels and reducing the incidence of postoperative wound infections in diabetic patients having elective hip arthroplasty.

Patients and Methods

This prospective randomized controlled trial was carried out on 40 patients aged from 35 to 70 years old, both sexes, diagnosed with type II diabetes underwent American Society of Anaesthesiologists (ASA) II or III who subjected to elective hip arthroplasty The research was conducted between January 2023 and June 2023, after clearance from the Ethical Committee of Tanta University Hospitals in Tanta, Egypt. The patient provided an informed written consent. Exclusion criteria were cases with diabetic ketoacidosis (DKA), history of complications from diabetes as diabetic foot and pregnant women, uncontrolled cases with haemoglobin A1C above 8% (uncontrolled diabetes) and non-elective surgeries.

Randomization and allocation

The process of randomizing the chosen participants was carried out utilizing computer-generated numbers. The subjects were divided into two equal groups using a sealed opaque envelope approach. Group C (control group): subjected to sliding scale and Group P (protocol group): subjected to insulin infusion in a concentration of 100U insulin on 100mL of normal saline and if there was no response to initial dose of insulin or still measurements were higher than preset range, doses were doubled.

Every patient undergoes a comprehensive evaluation, including a thorough medical history, a general assessment, a complete examination of the affected hip joint, radiological re-evaluation, and laboratory investigations such as a complete blood count (CBC), prothrombin time and concentration (PT and PC), partial thromboplastin time (PTT), kidney and liver function tests. Additionally, the patient's glycaemic control status is assessed using HbA1c.

Day before to surgery

24 hours prior to surgery oral hypoglycaemic drugs and insulin will be stopped; each patient started insulin therapy using Actrapid® insulin according to their assigned study group for 24 hours in the intensive care unit (ICU). All patients subjected to low carb diabetic food of three meals with 6 hours in-between. Patients fasted 8 H for solids, 4 H for unclear fluids and 2 H for clear fluids before operation. When the patient started fasting, dextrose 5% infusion was started at a rate of 100 ml/h to supply glucose basal body needs 5gm/h, avoid metabolic changes of starvation and continued until patient is cleared to eat again postoperatively. In addition, insulin basal needs were supplied at all times independent to insulin given in the study protocols at a dose of 2U/H IV bolus or infusion according to the allocated group during the study even if blood glucose levels were within preset range and stopped only when blood glucose values were below 110 mg/dl.

Day of operation

We connected all patients to full monitoring in the operating room, which included an electrocardiogram (ECG), non-invasive blood pressure (NIBP), and pulse oximetry (SpO2). We recorded all patients' baseline vital signs. Then, we inserted an intravenous line, gave each patient 15 ml/kg of IV crystalloid as a preload, hooked up nasal oxygen, and gave each patient 2 mg of midazolam for sedation. Combined spinal epidural anaesthesia were used unless contraindicated at which patient will be excluded from the study. Patients were excluded from the study If intraoperative severe hypotension occurred and vasopressors were given, as it would affect the capillary blood glucose levels. All patients were provided with standardized perioperative treatment to prevent infections for the whole duration of the research. IV antibiotics were administered within 1 hour after the incision. The skin will be cleansed using an alcohol and iodine solution.

Perioperative Blood glucose levels control

Blood glucose levels were measured in all patients by finger-stick glucose device at baseline (before induction of anesthesia), hourly during surgery and in the ICU during the study. The aim was to maintain blood glucose level between 110-180 mg/dl.

Group C: Control group (sliding scale): Insulin was given IV bolus.

Group P: Protocol group (insulin infusion): Regular insulin was administered in protocol group in a concentration of 100U insulin on 100mL of normal saline. Infusion was initiated.

Postoperative care

All patients were admitted to the ICU to continue the study for insulin protocols for 24 hours then they were stopped, and patients were transmitted to the ward or stayed in the

ICU according to their condition with standard insulin regimen of ICU or ward Antibiotics. Following the operation, all patients were administered intravenous third generation cephalosporin for a duration of 5 days. Subsequently, they were released from the hospital and prescribed oral broad-spectrum antibiotics, which were maintained until the sutures were removed, about 15 days after the surgery.

All patients are subjected to history taking, blood glucose levels, procalcitonin (PCT), leukocytic count, ESR and CRP measurement, wound condition, episodes of hypoglycemia, length of hospital stay was recorded, and 28-day mortality rate was recorded.

The primary outcome was perioperative blood glucose levels. The secondary outcomes were length of hospital stay, 5 days postoperative wound infection rates and PCT, ESR, CRP and leukocytic count in the immediate postoperative period.

Sample Size Calculation

Using G. power 3.1.9.2. The calculated sample size is (N>18) per group based on the following considerations: 95% level of significance (2 tailed), 80% power of the study, group ratio 1:1 and blood sugar level (the primary outcome) was 146 ± 24.93 with insulin infusion and 171±27.98 with sliding scale according to a previous study.

Statistical analysis

The statistical analysis was conducted using SPSS v26 software (IBM Inc., Chicago, IL, USA). The quantitative variables were expressed as the mean and standard deviation (SD) and compared between the two groups using an unpaired Student's t-test. The qualitative variables were shown as frequency and percentage (%) and examined using the Chi-square or Fisher's exact test, as applicable. A two-tailed P value less than 0.05 was deemed to be statistically significant.

Results

Regarding age, sex, BMI, weight, height, ASA and duration of surgery, there was non- significant difference between both studied groups (p> 0.05). Table 1

Table 1: Comparison between the studied groups of demographic characteristics, ASA and duration of surgery

		Group P (n= 20)	Group C (n= 20)	95% CI	P
Age (years)		63.50±4.741	60.90±4.656	0.41, 5.61	0.088
Sex	Male	12 (60.0%)	11(55.0%)	2.05, 2.15	0.749
	Female	8 (40.0%)	9 (45.0%)		
Weight (kg)		95.58±7.547	94.62±7.595	3.88, 5.81	0.689
Height (m)		1.74±0.059	1.74±0.060	0.03, 0.04	0.731
BMI (kg/m^2)		31.40±1.831	31.32±1.842	1.10, 1.25	0.897
ASA	II	17 (85.0%)	15(75.0%)	2.37, 2.57	0.429
	III	3 (15.0%)	5 (25.0%)		
Duration of surgery		3.25±0.698	2.88±0.646	0.06, 0.81	0.086

Data are presented as mean ± SD or frequency (%), * significant p value < 0.05, CI: 95% confidence interval of the difference between both groups, BMI: Body mass index, ASA: American Society of Anesthesiologists.

Regarding serum HB, WBCs Platelets, prothrombin time (seconds), liver and renal function tests parameters, Statistical analysis revealed no significant difference (p> 0.05) between the two groups under consideration. Table 2

Table 2: Comparison between the studied groups of baseline laboratory results

	Group P (n= 20)	Group C (n= 20)	95% CI	P
HB (gm/dl)	11.80±0.707	12.00±0.992	0.76, 0.35	0.456
WBCs	5.90±1.078	5.71±1.120	0.51, 0.89	0.588
Platelets	278.05±110.158	269.60±105.615	60.63, 77.53	0.806
Prothrombin time (seconds)	15.18±0.496	15.09±0.399	0.20, 0.38	0.531
HbA1C	7.24±0.419	7.32±0.446	0.35, 0.20	0.587
AST (u/l)	21.81±3.235	23.25±4.372	3.90, 1.02	0.244
ALT (u/l)	22.73±3.728	24.39±4.926	4.45, 1.14	0.238
Bilirubin (mg/dl)	1.01±0.190	1.09±0.207	0.20, 0.05	0.241
Albumin (gm/dl)	4.23±0.344	4.09±0.370	-0.08, 0.38	0.192
Creatinine (mg/dl)	1.01±0.157	0.95±0.132	-0.03, 0.15	0.199
Urea (mg/dl)	33.83±10.476	39.08±8.853	11.45, 0.96	0.095

Data are presented as mean ± SD * significant p value < 0.05, CI: 95% confidence interval of the difference between both groups, HB: Hemoglobin, AST: Aspartate transaminase, ALT: alanine aminotransferase.

As regard intraoperative HR MAP, follow-up, there was non-statistically significant difference between both studied groups regarding subsequent HR measurements prior surgery start (baseline), and at 15, 30, 45. 60, 90, 120, 150, 180, 210 and 240 minutes. All measurements were slightly higher in group C, but the difference was not statistically significant (p> 0.05) for all readings. Regarding RBG, there was statistically significant decrease in the random blood sugar measurements in group P who were subjected to insulin infusion than group C who subjected to sliding insulin scale at 1, 2, 3 and 4 hours follow up during surgery (p< 0.001 for all measurements). Table 3

Table 3: Intraoperative HR, MAP and RBG follow-up of the studied groups

	Group P (n= 20)	Group C (n= 20)	95% CI	P
Heart rate (bpm)				
Baseline	80.90±9.835	82.95±10.344	8.51, 4.41	0.525
15 min	82.05±10.570*	85.35±10.484*	10.04, 3.44	0.328
30 min	81.75±10.026	85.70±10.643*	10.57, 2.67	0.234
45 min	81.70±9.847	85.40±10.840*	10.33, 2.93	0.266
60 min	81.65±10.261	84.60±10.684*	9.66, 3.76	0.379
90 min	81.80±9.998	84.60±11.147*	9.58, 3.98	0.408
120 min	81.60±9.848	84.65±10.989*	9.73, 3.63	0.361
150 min	82.61±10.455	87.00±9.771*	11.49, 2.71	0.217
180 min	83.43±10.617	88.36±11.218*	14.01, 4.14	0.272
210 min	84.00±11.119	92.67±8.524*	19.67, 2.33	0.114
240 min	83.50±15.123	98.50±4.950	42.88, 12.88	0.236
MAP (mmHg)				
Baseline	95.25±5.794	95.25±7.461	4.28, 4.28	0.990
15 min	89.80±6.387*	89.65±7.802*	4.41, 4.71	0.947
30 min	89.85±6.302*	89.50±8.326*	4.38, 5.08	0.882
45 min	89.95±5.969*	90.00±8.608*	4.79, 4.69	0.983
60 min	89.50±6.304*	89.75±8.884*	5.18, 4.68	0.919
90 min	89.80±5.988*	89.60±9.293*	4.80, 5.20	0.936
120 min	90.40±5.835*	89.70±9.804*	4.46, 5.86	0.785
150 min	90.56±6.119*	88.69±10.669*	4.12, 7.86	0.530
180 min	90.43±6.009*	90.55±9.470*	6.54, 6.31	0.970
210 min	89.58±5.534*	93.67±7.789	10.79, 2.62	0.215
240 min	89.50±6.595*	94.00±1.414	16.58, 7.58	0.397
RBG (mg/dl)				
Baseline	120.75±20.542	122.25±23.740	15.71, 12.71	0.832
1 hour	124.60±20.625*	142.90±26.784*	33.60, 3.00	0.020*
2 hours	128.75±22.934*	164.85±26.176*	51.85, 20.35	< 0.001*
3 hours	130.45±22.020*	171.25±26.083*	56.25, 25.35	< 0.001*
4 hours	129.55±21.350*	171.25±26.093*	56.96, 26.44	< 0.001*

Data are presented as mean ± SD or frequency (%). * Indicates a significant statistical difference between a reading and the respective baseline value. Significant p value < 0.05, CI: 95% confidence interval of the difference between both groups, HR: heart rate, MAP: mean arterial pressure, RBG: random blood sugar.

As regard postoperative infection rate for 5 days follow-up of the studied groups, our results revealed that infection rate was 0% in both studied groups and both groups were matched (P=1). Table 4

Table 4: Postoperative Infection rate follow-up of the studied groups

Infection rate	Group P (n= 20)	Group C (n= 20)	P
Day 1	0 (0.0%)	0 (0.0%)	1
Day 2	0 (0.0%)	0 (0.0%)	1
Day 3	0 (0.0%)	0 (0.0%)	1
Day 4	0 (0.0%)	0 (0.0%)	1
Day 5	0 (0.0%)	0 (0.0%)	1

Data are presented as frequency (%). P is significant when < 0.05.

As regard postoperative random blood sugar follow-up, there was significant decrease in the RBG measurements in group P who were subjected to insulin infusion than group C who subjected to sliding insulin scale at the 1st, 2nd, 3rd, 4th, 5th, 6th, 7th and 8th hours follow up after surgery (p< 0.001 for the first 6 hours, P= 0.004 for the 7th hour, and P= 0.041 for the 8th hour measurements). However, there was non-statistically significant difference between both studied groups regarding random blood sugar measurements after the 8th hour passage (from the 9th till the end of 24 hour follow after surgery) (p< 0.001 for all measurements) (p> 0.05). As regard postoperative serum PCT levels for 5 days follow-up, there was significant decrease in the serum PCT levels in group P than group C (P= 0.0035 for the 2nd day, and P= 0.043 for the 3rd day). However, there was non-significant difference between both studied groups regarding serum PCT levels at the baseline, 1st, 4th and 5th days post-operative (p> 0.05). Table 5

Table 5: Postoperative RBG and PCT follow-up of the studied groups

	Group P (n= 20)	Group C (n= 20)	95% CI	P
RBG (mg/dl)				
1 hour	b	171.60±25.964*	57.30, 26.60	< 0.001*
2 hours	128.80±21.535*	166.75±25.573*	53.08, 22.82	< 0.001*
3 hours	128.55±21.593*	165.55±25.362*	52.08, 21.92	< 0.001*
4 hours	128.20±21.365*	163.45±25.132*	50.18, 20.32	< 0.001*
5 hours	127.70±21.156*	159.35±24.917*	46.45, 16.85	< 0.001*
6 hours	126.65±21.060*	155.20±24.535*	43.19,13.91	< 0.001*
7 hours	125.40±20.684*	147.20±24.063*	36.16, 7.44	0.004*
8 hours	123.75±20.558*	138.65±23.798*	29.14, 0.66	0.041*
9 hours	122.30±20.474*	130.55±23.721*	22.43, 5.93	0.246

10 hours	120.60±21.838	122.45±24.451	16.69, 12.99	0.802
11 hours	120.00±20.355	122.05±23.196	16.02, 11.92	0.768
12 hours	120.85±20.806	122.30±24.242	15.91, 13.01	0.840
13 hours	121.10±20.991	122.90±24.743	16.49, 12.89	0.805
14 hours	120.30±20.678	122.45±24.390	16.62, 12.32	0.765
15 hours	120.50±20.967	122.60±23.424	16.33, 12.13	0.767
16 hours	120.10±20.583	122.30±23.976	16.50, 12.10	0.757
17 hours	120.65±21.092	121.80±24.034	15.62, 13.32	0.873
18 hours	120.75±20.094	121.80±23.087	14.90, 12.80	0.879
19 hours	121.20±20.206	121.80±23.955	14.79, 13.59	0.932
20 hours	120.60±20.510	122.85±24.108	16.58, 12.08	0.752
21 hours	121.25±19.620	122.35±23.471	14.95, 12.75	0.873
22 hours	119.60±21.197	121.65±23.419	16.35, 12.25	0.773
23 hours	119.90±20.943	122.40±23.574	16.77, 11.77	0.725
24 hours	119.55±21.289	122.05±23.494	16.85, 11.85	0.726
PCT				
Baseline	0.04±0.015	0.03±0.017	0.00, 0.02	0.148
Day 1	0.06±0.027*	0.08±0.025*	0.03, 0.00	0.052
Day 2	0.06±0.031*	0.08±0.027*	0.04, 0.00	0.035*
Day 3	0.07±0.033*	0.09±0.026*	0.04, 0.00	0.043*
Day 4	0.07±0.033*	0.09±0.028*	0.04, 0.00	0.070
Day 5	0.07±0.036*	0.09±0.030*	0.04, 0.00	0.094

Data are presented as mean ± SD. * Indicates a significant statistical difference between a reading and the respective baseline value, significant p value < 0.05, CI: 95% confidence interval of the difference between both groups, RBG: random blood sugar, PCT: Procalcitonin.

There was non-significant difference between both studied groups regarding TLC, ESR, CRP at the baseline, 1st, 2nd, 3rd, 4th and 5th days post-operative (P > 0.05 for all). TLC was lower in in group P who were subjected to insulin infusion than group C who subjected to sliding insulin scale in all measurements except at the baseline, but the difference was not significant. Regarding hospital stay, there was significant difference (P =0.192). Table 6

Table 6: Postoperative TLC, ESR and CRP follow-up of the studied groups

	Group P (n= 20)	Group C (n= 20)	95% CI	P
TLC (*10^3)				
Baseline	5.90±1.078	5.71±1.120	0.51, 0.89	0.588
Day 1	11.06±1.944*	11.11±1.935*	1.29, 1.19	0.935
Day 2	9.66±1.656*	9.76±1.757*	1.20, 0.98	0.840
Day 3	8.44±1.427*	8.59±1.562*	1.11, 0.81	0.753
Day 4	7.40±1.185*	7.58±1.406*	1.02, 0.65	0.655
Day 5	6.43±1.045	6.67±1.228*	0.97, 0.49	0.510
ESR				
Baseline	6.65±3.588	6.30±3.585	1.95, 2.65	0.759
Day 1	42.50±7.667*	45.30±9.974*	8.49, 2.89	0.326
Day 2	74.85±9.675*	72.90±11.021*	4.69, 8.59	0.556
Day 3	55.30±9.415*	55.60±7.279*	5.69, 5.09	0.911
Day 4	41.65±7.307*	42.50±7.134*	5.47, 3.77	0.712
Day 5	31.40±6.878*	32.55±6.817*	5.53, 3.23	0.598
CRP				
Baseline	2.60±1.789	3.05±2.038	1.68, 0.78	0.463
Day 1	20.45±6.605*	19.60±7.776*	3.77, 5.47	0.712
Day 2	32.50±5.216*	30.15±5.294*	1.01, 5.71	0.165
Day 3	24.30±4.450*	22.10±4.352*	0.62, 5.02	0.122
Day 4	18.10±3.959*	16.40±3.515*	0.70, 4.10	0.159
Day 5	13.55±2.743*	12.45±2.724*	0.65, 2.85	0.211
Hospital stay (days)				
	5.15±1.461	4.55±1.395	0.31, 1.51	0.192

Data are presented as mean ± SD. * Indicates a significant statistical difference between a reading and the respective baseline value., significant p value < 0.05, CI: 95% confidence interval of the difference between both groups, TLC: total leucocyte count, ESR: erythrocyte sedimentation rate, CRP: C-reactive protein.

Discussion

One of the most prevalent orthopaedic treatments is hip arthroplasty, which involves replacing the hip joint [10].

Hyperglycaemia is a distinct indicator of both in-hospital illness and death, associated with an increased occurrence of problems after surgery, including the need for blood transfusion, pneumonia, delayed release from the hospital, surgical site infections, and death while in the hospital [11].

Regarding the fitness of patients before surgery by ASA physical status classification system, most cases in both groups in our research were class II. 85.0% in groups P and 75% in group C (p> 0.05). Wu and his co-workers [12], reported that the mean ASA 2.8±0.6. Ylikoski and his colleagues. [13]. Reported that most of their cases either

complicated or not had ASA 2 (65.9% of the non-diabetic cases and 42.4 in the diabetes cases while 24.4 the non-diabetic cases and 57.6% of the diabetics had ASA 3.

Regarding the baseline preoperative laboratory investigations of the study participants, our results revealed that there was non-statistically significant difference between both studied groups regarding serum Hb (gm/dl), WBCs Platelets, PT (seconds), liver and renal function tests parameters (p> 0.05). The mean HbA1C of cases was matched in between study groups as it was 7.24±0.419 in groups P and 7.32±0.446 in group C (P =0.587). Patients were selected for elective operation and the routine tests were suitable for operations. The mean Hb conc. of cases involved in our study groups (11.80±0.707, 12.00±0.992) in group P and S respectively) was in line with that reported by Wu and his co-workers [12] of 11.96±1.6.

The relationship between the standard A1C threshold and outcomes after orthopedic surgery has shown contradictory results, perhaps because to changes in the methodology of different studies [13, 14]. Tarabichi *et al*. [15] discovered that having an A1C level higher than 7.7% indicated a greater likelihood of this heightened risk, therefore endorsing the preoperative A1C goal of less than 8%. As regards the duration of surgery of the studied groups: the mean duration of surgery was lower in group C (2.88±0.64) hours than in group P (3.25±0.698 hour) but the difference was not statistically significant (P =0.086). Samir *et al*. [16] reported a slightly lower near mean surgery time using two different anesthesia protocols in two groups; 118±16.3 and 126±10.02 minutes. Aljuaid *et al*. [17] also reported a very close time to our findings that was 140.92± 47.39 minutes.

As regard intraoperative vitals of the studied groups, our results revealed that there was non-statistically significant difference between both studied groups regarding subsequent HR measurements prior surgery start(baseline), and at 15, 30, 45.60, 90, 120, 150, 180, 210 and 240 minutes. All measurements were slightly higher in group C but the difference was not statistically significant (p> 0.05 for all readings). Furthermore, our results revealed that there was non-statistically significant difference between both studied groups regarding subsequent MAP measurements prior surgery start (baseline), and at 15, 30, 45, 60, 90, 120, 150, 180, 210 and 240 minutes (p> 0.05 for all readings). So, Spinal anesthesia provided hemodynamic stability, no episodes of severe hypotension or bradycardia.

A number of authors preferred the use of general anaesthesia (GA) due to its ability to maintain stable hemodynamic [18]. According to some sources, the use of spinal anaesthesia method is optimal for reducing cardiac side effects in elderly individuals undergoing spinal anaesthesia. [19]. Saber *et al*. [19] reported that on using spinal anesthesia for hip arthroplasty cases, the HR was comparable between the two groups throughout the surgery with no episodes of bradycardia as like our finding it fluctuate d between 70 and 90 and the mean blood pressure of their cases also swung between 80 and 100. Abdelrahman *et al*. [18] reported that the MAP after induction of anesthesia (mmHg) in their hip arthroplasty group was 86.90±19.677 and 77.70±13.5 then 85.17 ± 16.479 and 90±7.50. Then post cement insertion (mmHg), it was 78.57±16.7 and 69.60±17. in general and spinal anesthesia groups respectively.

Griffiths *et al*. [20]. Emphasized the significance of meticulous administration of anaesthesia above the specific choice of anaesthetic. White *et al*. [21] provided evidence supporting the notion that mortality is not associated with the kind of anaesthesia, but rather increases with a decrease in blood pressure. As regard intraoperative RBG follow-up of the studied groups, our results revealed that prior surgery start (at baseline) there was non-statistically significant difference between both studied groups regarding random blood sugar (p> 0.05). However, there was statistically significant decrease in the random blood sugar measurements in group P who were subjected to insulin infusion than group C who subjected to sliding insulin scale at 1, 2, 3 and 4 hours follow up during surgery (p< 0.001 for all measurements). As regard postoperative RBG follow-up of the studied groups, our results revealed that there was still statistically significant decrease in the random blood sugar measurements in group P who were subjected to insulin infusion than group C who subjected to sliding insulin scale at the 1st, 2nd, 3rd, 4th, 5th, 6th, 7th and 8th hours follow up after surgery (*p*< 0.001 for the first 6 hours, P= 0.004 for the 7th hour, and P= 0.041 for the 8th hour measurements).

However, there was no significant difference between the two groups studied in terms of random blood sugar measurements after 8 hours. Schricker and his colleagues [22] agreed with our findings that maintaining normal blood sugar levels during surgery using intravenous insulin and glucose (GIN) helped prevent damage to both short-term and long-term memory function. However, it is important to note that their study focused specifically on cases of open-heart surgery. Agreeing with our findings also, Khalil *et al*. [23] showed a marked improvement in postoperative liver parameters compared with the control group (*p*< 0.001).

Our results revealed that there was statistically significant decrease in the serum PCT levels in group P who were subjected to insulin infusion than group C who subjected to sliding insulin scale at the 2nd and 3rd, days post-operative (P= 0.0035 for the 2nd day, and P= 0.043 for the 3rd day). However, there was non-statistically significant difference between both studied groups regarding serum PCT levels at the baseline, 1st, 4th and 5th days post-operative (p> 0.05). In contrary, there was non-statistically significant difference between both studied groups regarding TLC, CRP or ESR at the baseline, 1st, 2nd, 3rd, 4th and 5th days post-operative (P > 0.05 for all). Regarding postoperative hospital stay: the mean duration of hospital stay was lower in group C (4.55 ± 1.395) days than in group P (5.15±1.461 days) but the difference was not statistically significant (P =0.192). McVey *et al*. [3] reported that Postoperative complications were equally likely in patients with DM (12.2%) and controls (12.9%) (p = 1.000). The impact of glycemic control on postoperative complications therefore remains unclear [3].

Our results aligned with the Aljuaid research as well. According to [24], the duration of stay was 3.21 (±0.96) days. According to Schroeder *et al*. [25], the intervention group's in-hospital length of stay seemed to be significantly shorter than that of the sliding scale group, but both groups' lengths of stay were still longer than those of our study (7 and 9.2 days, respectively, *p*< 0.005), and there was no obvious explanation for this difference. The expertise of the surgical team conducting the procedures and the abilities of the nurses and therapists who offer the postoperative care and rehabilitation may help to explain some of the difference in the typical postoperative length of stay. Furthermore, other elements that were shown to be contributing in earlier research-such as the lack of concurrent comorbidities,

physical health, and the other discharge criteria-should also not be disregarded. A patient may be less likely to request surgery when their health is poor, a general practitioner may be less likely to refer a high-risk patient to the clinic, and an orthopaedic surgeon or anaesthetist may advise against arthroplasty when the operative risk outweighs the potential gains in function, according to the rate of superficial SSI reported by McVey *et al*. [3].

Marchant *et al*. [26] concluded that HbA1c was not associated with postoperative morbidity (Including surgical site infection) or mortality [27].

Analysing laboratory biomarkers of infection is one of the most crucial phases in the diagnostic procedure for perioperative infection detection. Biomarkers may help with risk assessment, treatment monitoring, and diagnosis. Examples of biomarkers include white blood cell count (WBC), erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP). These blood markers, however, are not sensitive or precise enough to distinguish between inflammation resulting from a surgical damage response and inflammation caused by a bacterial infection. Prior research has shown that PCT is somewhat more effective in identifying bacterial infections because of its high specificity. According to earlier research, sepsis or a severe bacterial infection are strongly indicated by PCT values more than 2 ng/ml, although these conditions are unlikely if PCT levels are less than 0.5 ng/ml [28].

Limitations of our study was number of subjects was rather small and absence of long term follow up to detect remote complications, we recommend Normoglycemic hyperinsulinism may be of interest but there is a need for larger multicentre randomized controlled studies to assess its potential role.

Conclusions

The hyperinsulinemia-normoglycemic strategy proved to be a successful, long-lasting, and uncomplicated method for managing glucose levels in diabetic patients undergoing orthopaedic procedures. Consequently, the positive outcomes of this research may pave the way for the adoption of this approach in all orthopaedic departments within our hospital.

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