Effect of Preoperative Hemoglobin A$_{1c}$ Level on Acute Postoperative Complications of Total Joint Arthroplasty

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Abstract

Diabetes mellitus is a well-established risk factor for postoperative complications of total joint arthroplasty (TJA). We conducted a study to identify a specific hemoglobin A$_{1c}$ (HbA$_{1c}$) level at which immediate postoperative complication rates increased after TJA.

HbA$_{1c}$ levels were measured within 90 days before surgery. Complications were documented during the acute postoperative period. Charts were reviewed, and each patient was given a score based on how many of these postoperative complications occurred.

Overall, 118 patients were retrospectively analyzed between 2009 and 2011. Patients were grouped into 5 HbA$_{1c}$ level ranges, and a mean postoperative complication point score was obtained for each group. We found that mean postoperative complication rates increased along with HbA$_{1c}$ levels; HbA$_{1c}$ levels higher than 7.5% correlated strongly with a higher rate of postoperative complications.

These findings provide a good foundation for prospective studies and further evidence of the effects of HbA$_{1c}$ levels. If an adequate treatment plan for these patients emerges, these findings may help lower readmission rates as well.

I n the United States, arthritis and diabetes mellitus affect 46 million and 20 million people, respectively; 52% of patients with diabetes have some form of physician-diagnosed arthritis. As the incidence of diabetes increases, so does the number of diabetic patients who undergo hip and knee arthroplasty. Generally, the surgical intervention rate is higher for patients with diabetes than without.[1-5] Compared with patients who do not have diabetes, patients with diabetes are at increased risk for adverse events and have longer postoperative hospital stays.[1-5] Surgical intervention can disrupt

the management of diabetes, which can lead to hyperglycemia during the postoperative period.[1-6] Glycemic control is associated with outcomes in acute medical, general surgical, and trauma environments,[1,7-9] and other studies have demonstrated an association between elective surgery and physiologic stress, which can alter the ability of both diabetic and non-diabetic patients to regulate glucose metabolism.[10,11]

Optimal management of hyperglycemia has been shown to minimize complications of surgical intervention, whereas suboptimal perioperative glucose control associated with increased morbidity in the postoperative period. Furthermore, an association between diabetes and infection after orthopedic surgery has been reported.[1,3,12,13]

Patients with well-controlled diabetes are less likely to develop wound infection after total joint arthroplasty (TJA),[1] and optimizing blood glucose (BG) control in the perioperative period can lessen the adverse impact of hyperglycemia.[1,6] Hemoglobin A$_{1c}$ (HbA$_{1c}$), which is glycosylated or glycated hemoglobin, provides a serologic marker for the average systemic glucose concentration for the 3 months before measurement.[1-11] In its 2012 clinical practice guidelines, the American Diabetes Association recommended an HbA$_{1c}$ level of less than 7% for adults with diabetes (normal range, 4%-7%).[14]

We conducted a study to determine how many immediate postoperative complications occurred in patients with diabetes; if patients who had diabetes, high HbA$_{1c}$ levels (>7%), and frequent episodes of poorly controlled BG had a higher incidence of postoperative infections; and if patients who had diabetes, well-controlled HbA$_{1c}$ levels (4%-7%), and well-controlled BG had a lower incidence of infections.

Materials and Methods

After obtaining institutional review board approval for this study, we reviewed billing records in our institutional joint arthroplasty database to identify patients who had a TJA at Albert Einstein Medical Center (AEMC) in Philadelphia between January 2009 and December 2011. Patients who had primary total hip arthroplasty (THA), revision THA, primary total knee arthroplasty (TKA), and revision TKA were included. Patients were considered diabetic if they had a documented history of diabetes or, on preadmission testing, a random BG

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Table. Postoperative Complications (n)

Deep and superficial wound drainage	4
Urinary tract infection	0
Deep venous thrombosis	0
Pulmonary embolism	0
Infection	2
Blood product transfusion	9
Mental status change	1
Respiratory distress	1
Urinary catheter reinsertion	3

level higher than 200 mg/dL or a fasting BG level higher than 100 mg/dL. The senior author (JWS) performed all of the primary and revision procedures.

HbA$_{1c}$ levels were measured within 90 days before surgery. In the hospital, all patients were placed on an insulin sliding scale with a targeted BG level lower than 120 mg/dL. Complications were documented in the acute postoperative period (time of surgery until discharge to home/rehabilitation). Patients were categorized as diabetic or non-diabetic at time of surgery. They were identified as having diabetes at time of preoperative history and physical and medical clearance, or from the AEMC database. Patients with diabetes were then investigated for their latest preoperative HbA$_{1c}$ level. Of the 152 patients identified as diabetic, 118 (78%) had HbA$_{1c}$ levels measured within 90 days before surgery.
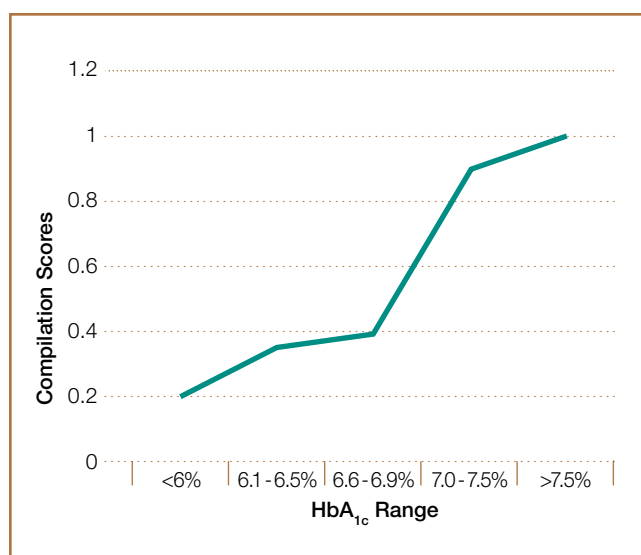

Figure. Postoperative complication scores increase as hemoglobin A$_{1c}$ (HbA$_{1c}$) levels increase.

Charts were retrospectively reviewed, and a total point score was given to each patient based on his or her number of postoperative complications. Nine complications were recorded: deep and superficial wound drainage, urinary tract infection, deep venous thrombosis, pulmonary embolism, infection, blood product transfusion, mental status changes, respiratory distress, and urinary catheter reinsertion (**Table**). Each complication was assigned a point score of 1. This system was developed by our in-house statistician. Each patient's point scores were totaled.

Statistical analysis was performed to determine the scope or degree of influence of preoperative HbA$_{1c}$ levels on postoperative complications. Logarithmic regression analysis was performed to determine if there was a correlation between HbA$_{1c}$ levels and complications. The patients were grouped into 5 HbA$_{1c}$ score ranges (>6%, 6.1%-6.5%, 6.6%-6.9%, 7%-7.4%, >7.5%), and a mean postoperative complication point score was obtained for each group. Another logarithmic regression analysis was performed to determine if there was a correlation between age at time of surgery and postoperative complications.

Results

Between January 2009 and December 2011, 236 patients had TJA. Of the 152 patients identified as diabetic, 118 (78%) had HbA$_{1c}$ levels measured within 90 days before surgery and were included in the study. Sixty-seven (57%) of the 118 patients were men, and 51 (43%) were women. Mean age was 58.6 years (range, 35-92 years). Mean HbA$_{1c}$ level was 6.9% (range, 5%-12%). There was no loss of patients during this study.

Patients were grouped into 5 HbA$_{1c}$ ranges (<6%, 6.1%-6.5%, 6.6-6.9%, 7%-7.4%, >7.5%), and a mean postoperative complication point score was obtained for each group. Logarithmic regression analysis was performed to determine if there was a correlation between preoperative HbA$_{1c}$ levels and postoperative complications.

We found that mean postoperative complication rates increased along with HbA$_{1c}$ levels ($R^2 = 0.87$) (**Figure**). Moreover, we established that an HbA$_{1c}$ level higher than 7.5% strongly correlated with higher incidence of postoperative complications. In addition, age at time of surgery did not correlate with mean postoperative complication point scores.

Discussion

Of 118 patients who underwent primary or revision THA, or TKA, those with HbA$_{1c}$ levels higher than 7.5% and poorly controlled diabetes had a postoperative complication rate significantly higher than that of diabetic patients with HbA$_{1c}$ levels lower than 7.5% and tighter glycemic control.

To our knowledge, this is the first study to evaluate a specific HbA$_{1c}$ level at which postoperative complication rates increased after TJA. The results confirmed our hypothesis that significantly more complications occur for patients with uncontrolled diabetes than for patients with controlled diabetes and patients without diabetes.

Aside from identifying a specific HbA$_{1c}$ level at which postoperative complication rates increase after TJA, other informa-

tion developed within this study is consistent with the current orthopedic literature. Marchant and colleagues[1] found a 2.28 times higher incidence of wound infection in TJA patients with uncontrolled diabetes. Lai and colleagues[15] found that patients with an infected TJA had a higher incidence of suboptimally controlled diabetes. Diabetes as a comorbid condition is associated with higher post-TJA complication rates.[16,17]

In one of the largest studies conducted on patients with diabetes, Iorio and colleagues[3] found that the infection rate for diabetic patients was higher than that for non-diabetic patients, but there was no correlation between HbA$_{1c}$ levels and infection rates. However, they separated HbA$_{1c}$ levels into only 2 groups (>7%, <7%) and evaluated only for postoperative infections, whereas we separated HbA$_{1c}$ levels into more groups and evaluated for infections and other postoperative complications.

For patients who have lower extremity TJA, hyperglycemia and uncontrolled diabetes are associated with higher incidence of surgical complications, medical complications, symptomatic pulmonary embolus, and mortality.[1,11,16-21] HbA$_{1c}$ level is a serologic marker for BG control in patients with diabetes, and, though not a specific marker for infection, it can be a valuable tool in determining operative timing.

Our study had its limitations. First, it was retrospective, and we relied on an electronic database to identify patients with the investigational factors of interest. The coding used to identify patients has not been validated against clinical data, though the National Inpatient Sample data have been validated against the National Hospital Discharge Survey.[22] We do not know to what extent coding errors might have affected study results, though models with and without imputation demonstrated no difference. In our study, data collected from 2 years were pooled to form a single sample; it is possible that care patterns for patients with diabetes may have changed during the study period.

In conclusion, diabetic patients who had TJA performed— particularly those with HbA$_{1c}$ levels higher than 7.5%—were at increased risk for early postoperative complications. Strict glucose control and lower preoperative HbA$_{1c}$ levels decreased the risk for these complications. We believe these findings provide a good foundation for prospective studies, and further evidence of the effects of HbA$_{1c}$ levels. If an adequate treatment plan for these patients emerges, these findings may help lower readmission rates as well.

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