EDITOR'S CHOICE

Impact of Variation of Corticosteroid Dose, Injection Site, and Multiple Injections on Blood Glucose Measurement in Diabetic Patients

Jonathan Twu, MD,* Neil Patel, BS,† Jennifer Moriatis Wolf, MD,* Megan Conti Mica, MD*

Purpose This study examined how corticosteroid dose, injection site location, and patient demographics affect blood glucose level after corticosteroid injection in diabetic patients.

Methods We prospectively enrolled 70 patients with diabetes mellitus requiring upper- and/or lower-extremity corticosteroid injections. Patients measured fasting and postprandial blood glucose for 14 days after the injection. Blood glucose from days 1 through 7 was compared with the average of days 10 through 14, acting as control. Changes in blood glucose were compared by corticosteroid dose, injection location, patient demographics, and insulin use.

Results Patients who underwent shoulder, wrist, or hand injections and patients who received multiple injections had no significant elevations in fasting or postprandial blood glucose, whereas those with knee injections had a significant increase in fasting blood glucose on postinjection days 1 and 2. Preinjection hemoglobin A1C had a significant effect on postinjection blood glucose whereas corticosteroid dose, body mass index, insulin use, and the number of injections had no significant effect on the elevation of blood glucose. There were no cases of diabetic ketoacidosis in any subjects.

Conclusions Patients receiving corticosteroid injections in the upper extremity did not experience significant increases in blood glucose whereas those undergoing knee corticosteroid injections demonstrated elevated blood glucose levels. Because poorer glucose control was associated with greater elevations in blood glucose after injection, patients with higher hemoglobin A1C should be counseled to monitor postinjection glucose more closely. *(J Hand Surg Am. 2018;43(8):738–744.*

Type of study/level of evidence Therapeutic II.

Key words Blood glucose, corticosteroid, diabetes mellitus, triamcinolone.

*From the *Department of Orthopedic Surgery, University of Chicago; and the †Rosalind Franklin University of Medicine and Science, North Chicago, Chicago, IL.*

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

Corresponding author: Megan Conti Mica, MD, Department of Orthopedic Surgery, University of Chicago, 5841 S Maryland Avenue, Chicago, IL 60637; e-mail: mcontimica@bsd.uchicago.edu.

0363-5023/18/4308-0006$36.00/0
https://doi.org/10.1016/j.jhsa.2018.06.005

CORTICOSTEROID INJECTIONS (CSIS) are effective in treating a variety of upper- and lower-extremity conditions including osteoarthritis, bursitis, epicondylitis, tendinitis, carpal tunnel syndrome, and trigger fingers.[1–10] Patients with diabetes have a 10% higher risk for developing trigger fingers and adhesive capsulitis of the shoulder compared with those without diabetes.[11] Two recent systematic reviews showed a consistent elevation in

postinjection blood glucose in the first 24 to 72 hours after CSIs.[12,13] The inherent sensitivity of diabetic patients to transient elevations in blood glucose has created controversy regarding when to provide diabetic patients with CSIs, how much corticosteroid should be used, and how many injections can be given at once. Although blood glucose levels have been shown to rise as high as 500 mg/dL, there are no documented examples of a patient developing diabetic ketoacidosis or diabetic coma, which are considered the most severe complications in diabetic patients.[12–14] While retrospective studies examined the effects of demographics, diabetes control regimen, long-term diabetic control (hemoglobin A1C [HgbA1C]), and body mass index (BMI), there has not been a comparative study examining how these patient characteristics affect the severity and duration of the increase in blood glucose after CSIs based on the steroid dose, location of injection (upper vs lower extremity), type of injection (intra-articular vs extra-articular), and impact of multiple injections involving the knee, shoulder, elbow, and hand. In addition, there are no clinical guidelines regarding the safety of single or multiple CSIs in diabetic patients and whether HgbA1C, BMI, or a control regimen can increase the risk for prolonged elevation in blood glucose after CSI. The purpose of this study was to determine the effect of the injection location, injection type, corticosteroid concentration, number of injections, and patient demographics on blood glucose levels. We hypothesized that lower-extremity, intra-articular, and multiple injections would be associated with a greater elevation in blood glucose compared with upper-extremity, soft tissue, and single CSIs. We also hypothesized that HgbA1C, BMI, and the need to receive insulin as a control regimen would affect blood glucose after CSIs.

MATERIALS AND METHODS

The study protocol was approved by the institutional review board before data collection and informed consent was obtained for each participant. Patients were approached for possible recruitment if they had a documented diagnosis of diabetes mellitus and were offered a CSI involving the glenohumeral joint, subacromial space, elbow joint or tendon origin, first dorsal compartment, thumb basilar joint, carpal tunnel, trigger finger, or knee. Patients were excluded if they were aged less than 18 years, had received an injection in the previous 3 months, or were unable to complete glucose measurements.

Patients enrolled in this study received standard injection mixtures of triamcinolone (range, 5–80 mg) and were given a diary log to record one fasting and one 2-hour postprandial blood glucose measurement per day for 14 days, based on current testing standards set by our institution's endocrinology section. Upper-extremity injections were given by 1 of 4 fellowship-trained hand surgeons at our tertiary care institution; knee injections were given by one board-certified orthopedic surgeon. A standardized glucometer, which included lancets and test strips, was given to all patients. Patient demographics, BMI, type of diabetes, HgbA1C, and the diabetes control regimen (insulin vs no insulin) were recorded for data analysis. After 2 weeks, a member of the research team contacted the patients by phone to collect blood glucose measurements.

Each subject's fasting and postprandial blood glucose measurements on postinjection days 1 through 7 were compared with baseline. Baseline blood glucose was determined by taking the average blood glucose from postinjection days 10 through 14. This model was based on the study by Stepan et al,[5] which showed no significant increase in blood glucose past postinjection day 5. Postinjection days 8 and 9 were considered a washout period.[5]

Data analysis

We performed a sample size estimate before study initiation. To determine whether there were significant changes in postinjection blood glucose on days 1 through 7 compared with the average of days 10 to 14, 36 subjects were needed to detect a 20-mg/dL difference in blood glucose with an SD of 30 with 80% power. We performed longitudinal data analyses with linear mixed models. To make the data follow a normal distribution, we conducted log-transformation for the glucose values and tested the difference between the mean of log-values on each of the first 7 days and the average of days 10 through 14. We performed a mixed model that accounted for time (day-to-day measurements), corticosteroid dose, injection number (single vs multiple), injection type (knee, shoulder, or hand/wrist), BMI, insulin use, and HgbA1C as covariates and included a random intercept. Time was treated as a categorical variable and the correlation of log-values between pairs of time points on the same individual was estimated by a heterogeneous variance first-order autoregressive structure. To test the difference between the mean of log-values on each of the first 7 days and days 10 to 14, we used a Bonferroni corrected threshold that accounted for 7 repeated measurements and that made a P value of .007 the significant threshold.