Open Access

Article Type: Research Article

Volume 3 Issue 1 - 2025

SciBase Surgery

Elevated Day of Surgery Blood Glucose is not Correlated with Increased Complication Rates Following Carpal Tunnel Release

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Article Information

Received: Dec 10, 2024

Accepted: Jan 22, 2025

Published: Jan 29, 2025

SciBase Surgery - scibasejournals.org

Citation: Pelrine ER. Lesevic M, Novicoff W, Dacus AR. Elevated Day of Surgery Blood Glucose is not Correlated with Increased Complication Rates Following Carpal Tunnel Release. SciBase Surg. 2025; 3(1): 1013.

Abstract

Purpose: Presence of diabetes and elevated hemoglobin A1c values have been linked with poor hand surgical outcomes, but there has been a lack of research looking at whether Day of Surgery (DOS) blood glucose levels (BGL) are related to surgical outcomes. We aim to investigate this relationship in Carpal Tunnel Release (CTR) with the hypothesis that elevated DOS BGL will not be associated with worse CTR outcomes.

Methods: This is a retrospective chart review of all patients at a single institution undergoing CTR between Jan 2020 and October 2020. Subjects were split into two groups using a cutoff of BGL=200. The primary outcome was rates of complications in each group.

Results: 356 patients were included in the analysis, 41 of them had DOS BGL >200. The BGL >200 group had a significantly higher A1c, but there were no other significant differences in demographics between groups (Table 1). There was no significant difference in complication rates between groups. This was consistent across sub-group analysis of major and minor complication rates. We saw no significant difference in complication rates when groups were further divided by hemoglobin A1c level.

Discussion: DOS BGL is not correlated with increased complication rates after CTR. Same-day surgical cancellations due to elevated BGL cost hospital systems, disrupt surgeons' schedules, and burden the patient with rescheduling surgery and their recovery. Our data supports re-evaluating DOS BGL and a reason to cancel CTR procedures.

Keywords: Carpal tunnel release; Hyperglycemia; Carpal tunnel complications; Wrist surgery; Diabetes; Carpal tunnel syndrome.

Introduction

Carpal Tunnel Syndrome (CTS) is the most common peripheral nerve entrapment syndrome worldwide [1,2]. Carpal Tunnel Release (CTR), the current standard of care for severe and/or persistent CTS, is one of the most common hand surgery procedures in the United States with over 400,000 procedures performed annually. Post-operative complications are rare and include surgical site infections, intraoperative technical errors, and recurrence or persistence of symptoms [2].

Diabetes is a known risk factor for post-operative orthopedic surgery complications, particularly surgical site infections, as well as a risk factor for developing CTS [3,4]. Previous studies have also demonstrated an independent relationship between perioperative hyperglycemia and increased rates of surgical site infections in both orthopedic and general surgeries [5,6]. Essentially all of these studies have focused on hemoglobin A1c levels as the indicator for hyperglycemic states. However, there is relatively little data looking at Day of Surgery (DOS) Blood Glucose Levels (BGL) and outcomes of hand surgeries. We find DOS labs to be of particular interest, as they are a cited cause for surgery cancellations by the surgeon or anesthesiologist.

In this study, we aim to investigate the effect of perioperative hyperglycemia on CTR complication rates. It was hypothesized that patients with perioperative hyperglycemia would have similar rates of wound healing complications and soft tissue infections compared with those with perioperative blood glucose levels below cutoff values.

Methods

This was a retrospective chart review of patients treated at a single academic health center. Local Institutional Review Board approval was obtained prior to the collection or analysis of any data. Inclusion criteria were patients who underwent carpal tunnel release (open or endoscopic) at our institution between January 2020 and October 2022 *and* had a blood glucose level taken the day of their procedure. Exclusion criteria were patients that were undergoing other concomitant procedures, those that had carpal tunnel releases for reasons other than CTS, and those that did not have a minimum of 6 weeks of follow-up (including 3 subjects who were canceled due to high DOS BGL). Subjects were divided into two groups, one with DOS BGL <200 mg/dl (our control group) and the other with DOS >200 mg/dl (our hyperglycemia group).

CTRs were performed by any of 6 fellowship trained hand surgeons at our institution (two have plastic surgery training and 4 have orthopaedic surgery training). Procedures were performed at either our main hospital operating rooms or our outpatient surgery center. Blood glucose levels were obtained with a portable glucometer. It is standard protocol at our institution for DOS BGL to be drawn on all diabetic patients. It is at the discretion of anesthesia staff to draw BGL on other patients on a case-by-case basis. Most commonly, non-diabetic patients will have a DOS BGL drawn if they have another endocrine abnormality that would influence glucose control (i.e. – Addison's disease, polycystic ovarian syndrome, etc.). All subjects underwent subcutaneous local anesthetic injection, bier block, or region nerve block (performed by our anesthesia team) for pain control. Every subject underwent conscious sedation with a propofol drip for their anesthesia. Prior to incision, each subject received 1 dose of cefazolin as per our department's standard practices. At our institution, CTR incisions are closed with nonabsorbable suture and placed in a soft dressing. No subjects had to be admitted post-operatively.

The primary outcome was whether subjects experienced *any* adverse outcome or complication. Complications were further subdivided into minor and major complications. A complication was considered major if it required admission or operative intervention (surgical site infection requiring operative debridement, wound complication requiring return to OR, etc.). Minor complications included surgical site infection not requiring admission or surgical intervention, delayed wound healing, scar hypersensitivity, and recurrence of symptoms. Demographic and descriptive data was also collected on all subjects. Means and standard deviations were calculated for all continuous variables. Student's t-tests were performed to assess for statistical significance on continuous variables. Chi-square analyses were performed for categorical variables. Significance was set at p<0.01 to account for potential multiple comparison issues.

A secondary analysis was performed to determine any risk factors for complications following CTR as well as any confounding effect of elevated hemoglobin A1c levels. Our two study groups were further divided based on most recent A1c level ("low" vs "high"). A cutoff of <8 mg/dl was used to define "low" A1c as this is what our institution uses as the suggested target for outpatient elective surgery. This target is not a strict cutoff, though, which explains why we have subjects with A1c levels >8 mg/dl. This division created a total of four study groups – hyperglycemic/high A1c, hyperglycemic/low A1c, control/high A1c, control/lowA1c. Rates of major and minor complications were compared across all groups in a similar fashion to the primary analysis. In addition, binary logistic regression was used to determine the variables that were significantly associated with having a minor complication. In this analysis, p<0.01 was also used to determine significance.

Results

A total of 356 patients were included in the final analysis; 41 of them had a DOS BGL >200 mg/dl. There were no statistically significant differences between the groups in regards to age, sex, smoking status, severity of CTS, DM diagnosis, presence of neuropathy, and revision procedures. However, the hyperglycemia group had a significantly higher A1c (mean 7.0 (SD 1.2) vs. mean 9.1 (SD 1.8)), Table 1, p<0.01).

The overall complication rate was 22.5% for the control group and 31.7% for the hyperglycemia group. This difference was not a statistically significant. Our major complication rate was 0.9% in the control group and 2.4% in the hyperglycemia group This difference was also not statistically significant (Table 2, p>0.01). When study groups were divided by hemoglobin A1c levels we saw no significant difference between major or minor complication rates (Table 3, p>0.01). The binary logistic regression model included age, sex, DOS glucose, smoking status, presence of diabetes, and surgical approach (open vs. endoscopic). The stepwise approach (alpha to enter/remove = 0.15) resulted in only sex and age in the model, with only sex as a significant predictor (male vs. female OR = 0.37 (95% CI 0.19-0.73); p<0.01). However, the explained variance was only 4.2%, and the area under the ROC curve was 0.6542.

Table 1: Demographics.

Characteristics	Group		P value
	BGL <200 (n=315)	BGL >200 (n=41)	
Mean age (yrs±SD)	58.4±13.3	55.5±12.0	0.14
Sex (% female)	67.4	58.5	0.20
Current Smoker (%)	12.6	17.1	0.34
Mean A1c (% glycosylated hgb±SD)	7.0±1.2	9.1±1.8	**<0.05**
Severity of CTS (% moderate-to-severe & severe)	49.4	44.4	0.79
% open release (vs endoscopic)	77.6	75.6	
% revision procedure	7.3	2.4	0.57
Type 2 DM (%)	86.9	92.7	0.29
Neuropathy (%)	24	26.8	0.71
Mean follow-up time (days±SD)	235.6±297.0	241.2±305.1	

Table 2: Complication rates between groups.

	Group		p-value
	BGL <200 (n=315)	BGL >200 (n=41)	
Total # of Complications	80	15	
% of Subjects Experiencing at Least 1 Complication (n)	22.5 (71)	31.7 (13)	0.24
% of Subjects Experiencing a Minor Complication (n)	21.9 (69)	29.3 (12)	0.32
% of Subjects Experiencing a Major Complication (n)	0.9 (2)	2.4 (1)	0.46

Table 3: Subjects experiencing at least 1 complication by subgroup.

Group	Normoglycemic, A1c<8 (n = 223)	Normoglycemic, A1c >8 (n = 43)	Hyperglycemic, A1c<8 (n = 12)	Hyperglycemic, A1c >8 (n = 22)	p-value
Minor Complication, %(n)	24.7 (55)	23.2 (10)	33.3 (4)	27.3 (6)	0.92
Major Complication, %(n)	0.9 (2)	0 (0)	0 (0)	4.5 (1)	1.00

Minor complications included surgical site infection requiring antibiotics, delayed wound healing, scar hypersensitivity, and recurrence of symptoms.

Major complications included surgical site infections requiring OR debridement and wound complications requiring return to OR.

Discussion

We found no difference in CTR complication rates between those who had elevated BGLs and those who did not. Our overall complication rate was 23.6% for both minor & major complications, but 0.8% for major complications. Our definition of a major complication aligns with what most other studies reporting on this topic defined as a complication. When comparing our outcomes with those studies, we appear to have a similar complication rate [8,9]. Moreover, our inclusion criteria heavily selected for patients with diabetes since nondiabetics do not routinely get BGL measured at the time of surgery at our institution. Therefore, our data may be skewed to a higher risk population. It would be more appropriate to compare to our reported complication rates to those in diabetics. On literature review, surgical site infection rate after CTR in diabetics ranges from 0.1% to 4.2% [10,11]. This would suggest that our cohort is well within the expected complication rate.

We also saw no difference in complication rate when study groups were further divided by A1c level. This finding contradicts previous literature that shows a correlation between elevated A1c and increased wound complication and surgical site infections [3-5]. However, we had small sample sizes in many of our groups, especially in the elevated A1c cohort, and that can limit our ability to detect a statistically significant difference. Additionally, it should be noted that our major complication rate across all groups was quite low, suggesting that even if there is a difference it may not be a clinically significant one.

In the setting of our study, these results further support that one time hyperglycemia on the day of surgery does not increase a patient's risk for complication following CTR and we believe that it is not necessary to cancel elective CTR in this population. Avoiding these cancellations would have multiple benefits to the patients, surgeons, and hospitals. Patients in particular would avoid losing the time and effort spent scheduling and showing up for a cancelled surgery. This is particularly relevant in the diabetic population as glucose control prior to surgery can be difficult. NPO requirements can cause irregular glucose levels that may be difficult for these patients to adequately address through diet or changes in insulin dose. From the other perspective, not cancelling these cases would avoid surgeons losing valuable OR time and the hospital would avoid losing money. One study out of Finland found that, on average, every same day cancellation of an elective orthopaedic procedure cost the hospital 2,415 euros (approximately equal to $2671) [14].

We found that female sex was related to an increased rate of minor complications in our cohort. While CTS is more common in women and they may have more severe pre-operative symptoms, our findings contradict previous literature that has not shown sex differences in outcomes following CTR [15]. One hypothesis for this difference is time to return to work. Women, on average, return faster after carpal tunnel release surgery than men [16,17]. Earlier return to work, could put more stress on healing surgical incisions leading to more minor wound complications.

It is important to note that our study focuses solely on *surgical* outcomes in this patient population and not anesthetic concerns. However, CTR is typically performed at our facility under regional or local block with conscious sedation or no sedation at all. If sedation is used, propofol is the typical agent. Propofol is not known to have any increased side effects or complications in diabetic populations or in those with hyperglycemia. In comparison, general anesthetic has been correlated with complications related to hyperglycemia and the physiologic stresses it puts on patient's bodies [18]. Therefore, our results may not be generalizable to CTR procedures performed in that setting.

Limitations

There were several limitations to this study. First of all, it is a retrospective chart review. This restricts the outcomes that we can collect to what is regularly included in the medical record. For example, we were unable to look at any patient reported outcomes. Second, most of our subjects only had follow up to 6 weeks post-operatively (as this is when CTR patient typically get released from formal clinic follow-up). We may have missed complications and were limited in our ability to track patient symptom resolution that occurred farther along in the post-operative course. However, we assumed that any significant concerns or complications would prompt a clinic visit which would then be captured in our chart review. Finally, our study may not be powered to pick up differences in complication rates between groups, especially since the number of patients with high glucose was low. We had relatively low complication rates which typically requires a large cohort size to detect a difference. Only 3 patients across both study groups (and only 1 in the hyperglycemia group) experienced a major complication. Given this particularly low occurrence rate we believe CTR to be safe in patients with elevated DOS BGL. More study using a larger database of patients could be done, but at least 366 patients with high blood glucose undergoing CTR would be needed to reach 80% power to detect a 10% difference in complications between groups.

Conclusion

In conclusion, we saw no difference in complication rates between those who had elevated DOS BGL and those who did not. Our overall complication rate was low and comparable to previously reported studies. Larger studies and longer follow-up are needed, but our results suggest that there is no benefit to cancelling elective CTR based on DOS blood glucose >200 mg/dl.

Declarations

Conflict of interest: All authors declare that they have no conflicts of interest.

Ethical standards: Our study was performed in accordance with accepted ethical standards and with the approval of our local IRB.

Informed consent: In this particular study, the requirement for obtaining informed consent from participants has been waived by our local IRB.

Funding: No funding was required for this study.

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