Correlation of Venous Blood Sugar Measured by Lab Method and Capillary Blood Sugar Measured by Glucometer in Neurosurgical Patients Receiving Dexamethasone

Jyoti Sharma[1] Renu Bala[2] Seema Singh[2]

[1] Department of Anaesthesia, All India Institute of Medical Sciences, Bathinda, Punjab, India
[2] Department of Anaesthesia, Pandit Bhagwat Dayal Sharma Post Graduate Institute of Medical Sciences, Rohtak, Haryana, India

Address for correspondence Renu Bala, DM, Department of Anaesthesiology and Critical Care, Pandit Bhagwat Dayal Sharma Post Graduate Institute of Medical Sciences, Rohtak, Haryana, 124001, India (e-mail: neurodmrenu@yahoo.com).

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Abstract

Background Brain is vulnerable to extreme blood glucose levels that may occur due to multiple factors in neurosurgical patients; perioperative use of dexamethasone is the most common. Thus, frequent monitoring of blood sugar levels is advocated. This study aimed to assess correlation between venous blood sugar measured by lab method and capillary blood sugar by glucometer at various time intervals.

Materials and Methods This prospective and observational study was conducted in 20 adult patients of either sex, American Society of Anesthesiologists grade I to III, scheduled to undergo brain tumor resection. The patients who were already on dexamethasone and received intraoperatively 8 mg dexamethasone were enrolled. Standard anesthesia technique and intraoperative monitoring were followed in all patients. Venous sample was withdrawn and blood sugar analyzed in laboratory, while at the same time capillary blood sugar was tested by glucometer. The sampling was done at baseline, 1 hourly after dexamethasone administration till 4 hours and then 8, 12, and 24 hours. The correlation between the two values was assessed.

Results During the study, 160 venous and 160 capillary blood sugar levels were analyzed. Though capillary blood sugar levels were slightly higher than venous sugar levels, there was strong correlation between the two (Pearson correlation coefficient) with p-value less than 0.05 except at 24 hours when two values were not correlated.

Conclusion Capillary blood sugar levels by glucometer have good correlation with venous sugar levels; therefore, this method may be adopted routinely for frequent blood sugar estimation as it is reliable, easy, and practical.

Keywords

- neurosurgical
- dexamethasone
- blood glucose
- capillary
- venous

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Introduction

Ever since the first use of dexamethasone in a patient with glioblastoma by Galirich, the drug is widely used in neurosurgical patients.[1] It reduces tumor-associated edema. The mechanism decreases vascular permeability, reduces cerebral blood flow and blood volume, ultimately leading to reduction in intracranial pressure.[2] Thus, there is improvement in neurologic function. However, it is double-edged sword having various adverse effects, one of them being raised blood sugar level.[3] Therefore, frequent monitoring of blood sugar levels is advocated. This study aimed to assess correlation between venous blood sugar measured by lab method and capillary blood sugar by glucometer at various time intervals.

Materials and Methods

This prospective, observational study is a substudy of a larger study whose CTRI registration no is CTRI/2018/07/020822. Informed written consent was taken from the patients. Twenty adult patients of either sex belonging to American Society of Anesthesiologists (ASA) physical status I to III scheduled to undergo elective craniotomy under general anesthesia were enrolled for the study. The patients having pituitary disease, adrenal disorder, traumatic brain injury, those on steroid (in any form) except dexamethasone, diabetes mellitus, and pregnancy were excluded from the study. In the operating room, all routine monitors were attached. Intravenous access was obtained and a blood sample was sent to laboratory for blood sugar estimation. Simultaneously capillary blood sugar was tested by glucometer. A standard protocol for induction of anesthesia was followed. Airway was secured with cuffed endotracheal tube of appropriate size. Maintenance of anesthesia was done with isoflurane in O_2 (35%) and N_2O (65%). No glucose containing fluid was administered in the intraoperative period. Dexamethasone (8 mg) was administered during dural incision. Venous sample was taken for blood sugar estimation at following intervals:1 hour, 2 hours, 3 hours, and 4 hours after administrating dexamethasone, then every 4 hours till 12 hours. Capillary sugar was also measured at each time using glucometer.

Intraoperative monitoring of vitals was done at regular intervals. Central venous pressure (CVP) was maintained at 9 to 11cmH_2O. Fluid administration, management of blood loss, and brain bulge were done as per standard protocol. Rest of the anesthesia was managed as per standard protocol.

Statistical Analysis

Taking reference values from the study done by Boyd et al,[4] with α of 0.05 and β of 0.1, a sample size of 20 patients was taken. The entire data was compiled in MS excel and statistical analysis was done using SPSS version 22.0 and GraphPad prism version 7.0. Correlation between the capillary and venous blood glucose levels was drawn by Pearson correlation analysis

Results

Demographic profile of the patients is shown in ►**Table 1**. The surgical details including the indications and duration of surgery, intraoperative blood loss, urine output, and fluid and blood administration have been shown in ►**Table 2**. Correlation of capillary and venous blood sugar levels has been shown in ►**Table 3** and diagrammatically depicted in ►**Fig. 1**. Scatter plots at baseline, 4 hours, and 24 hours have been shown in ►**Figs. 2** to **4**, respectively.

Discussion

Maintaining euglycemia is very crucial in neurosurgical patients because both hypo and hyperglycemia are harmful for brain. There are numerous factors that may disturb glucose balance and thus it is pertinent to do frequent measurement of blood glucose levels. The traditional method of determining blood sugar levels is taking venous samples and sending it to laboratory for testing. From arterial sample also blood sugar can be estimated while doing arterial blood gas analysis provided the machine being used is having facility for it and calibrated. The third and commonly used method in intensive care unit (ICU) and outpatient department is use of glucometer and testing capillary blood glucose levels by finger prick method. Although in many centers bedside capillary glucose measurement have become the standard of care, previous literature has raised questions about disparity between these measured values and those obtained from traditional blood and serum assays from CVP and arterial source.[5]

In our study, we compared venous blood sugar levels done by laboratory method and capillary sugar levels by glucometer. Our results showed strong correlation between the two at all time points except at 24 hours after surgery. The peaks in both capillary and venous blood sugar levels were noted at 4 hours after dexamethasone administration. The mechanisms behind the increase are hepatic gluconeogenesis, increased lipolysis, muscle catabolism, and inhibition of peripheral glucose uptake in muscle and adipose tissue. Our findings are similar to earlier studies that have noticed increased blood sugar levels in response to dexamethasone in neurosurgical patients.[2,6,7]

The difference in both the values was in the range 2 to 14 mg/dL. In postprandial states, capillary sugar levels are usually 20 to 25% higher than venous blood glucose levels, while in fasting state the difference is very less (2–5 mg/dL).

Table 1 Demographic profile

	Mean ± SD	Range
Weight (kg)	59.05 ± 6.93	44–70
Height (cm)	159.60 ± 5.64	152–175
Gender (F/M)	10/10	50%/50%
Age (y)	43.00 ± 12.76	22–65

Abbreviation: SD, standard deviation.

Table 2 Surgical profile of the patients

Indications for surgery	Supratentorial tumors	9
	Infratentorial tumors	7
	Others	4
Duration of surgery (min)		299.50 ± 46.95
IV fluids (mL)	Colloids	399.33 ± 178.15
	Crystalloids	2100 ± 610.33
Blood loss (mL)		712 ± 255.04
Blood transfusion (mL)		571.42 ± 167.97
Urine output (mL)		902.50 ± 321.37

Abbreviation: IV, intravenous.

Table 3 Correlation of mean value of venous and capillary blood sugar

	Venous mean ± SD	Capillary mean ± SD	*r*-Value	*p*-Value
BL	95.55 ± 22.61	100.05 ± 20.93	0.619	0.004*
1 h	107.2 ± 17.07	112.35 ± 12.06	0.748	0.0001*
2 h	118.6 ± 19.55	128.55 ± 20.70	0.598	0.005*
3 h	124.95 ± 22.492	130.55 ± 5.62	0.701	0.0001*
4 h	128.1 ± 22.41	132.25 ± 20.916	0.779	0.0001*
8 h	116.35 ± 20.93	126.8 ± 24.42	0.676	0.001*
12 h	105.2 ± 19.92	107.9 ± 17.11	0.762	0.0001*
24 h	94.85 ± 14.73	108.65 ± 21.95	0.412	0.761

Abbreviation: SD, standard deviation.
*means p value significant (<0.05)

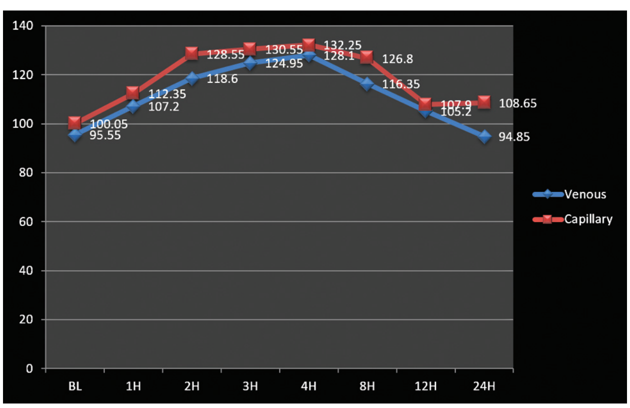

Fig. 1 Comparison of venous and capillary blood sugar values.

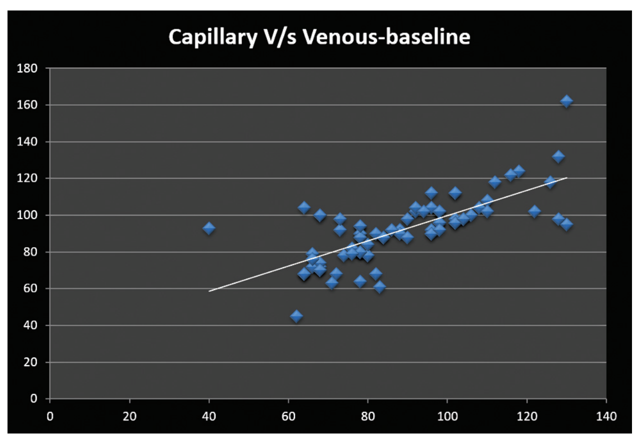

Fig. 2 Scatter plot at baseline.

Our patient group was surgical; hence, in fasting state good correlation was observed. There are few studies in the past that have assessed correlation of capillary and venous blood sugar levels, but most of them were performed in outpatient department, emergency department, or critical care units. Yaraghi et al compared venous and capillary blood glucose concentrations in poisoned patients in coma.[8] They found mean capillary blood glucose concentrations was slightly higher, although strongly correlated to venous blood glucose concentration with a correlation of 0.93. Patel and Patel also observed venous and capillary correlation in patients attending outpatient department of a tertiary care level hospital.[9] It was found that capillary glucose concentration was higher as compared to venous glucose concentration and both showed highly positive correlation among each other. Similar results were noted by Mallick and Ahsan and Shete et al that corroborated with our findings.[10,11] Even in diabetic patients admitted to ICU showed good correlation between capillary and venous blood sugar levels ($r = 0.995$,) though capillary values were 10% higher than venous values.[12] Our results are,

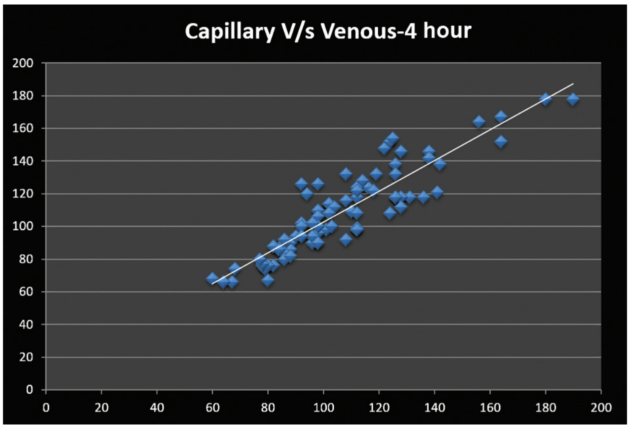

Fig. 3 Scatter plot at 4 hours.

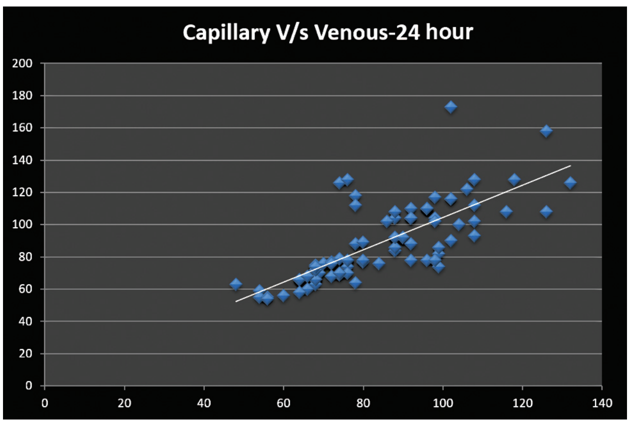

Fig. 4 Scatter plot at 24 hours.

however, different from those by Funk et al who found weak correlation in the two values in healthy volunteers.[13]

At 24 hours, the strong correlation between the two values was, however, not observed that could be due to several reasons like delay in laboratory analysis of venous blood glucose levels (blood glucose decreases by 5–7% per hour due to glycolysis), contamination while taking samples, variations in hematocrit, oxygen concentration, acidosis, and presence of hypotension.

Venous blood sugar levels may be a preferred method in wards and outpatient department but in ICU and operative settings when instant reporting is required so that adequate intervention can be done on time; it may not be a favorable method. Moreover, if CVP is not in situ repeated, pricking leading to hematoma, bleeding, and infection is also a concern. Talking in terms of cost, it is more expensive as compared to glucometer method. In neurosurgical patients when fluctuations in blood sugar levels are likely and maintenance of euglycemia is very important, capillary sugar monitoring should be done. The only concern is finger prick injury while taking repeated samples.

Our study had few limitations. First, our patient population were ASA I and II patients; it is difficult to comment whether same results will be translated in diabetic, critically ill patients or those who have glucose intolerance. Second, our results were in narrow range of blood sugar levels; the same findings may not be obtained at extremes of blood sugar levels. Third, arterial blood sugar levels could have been compared that also gives quick results, but our arterial blood gas machine did not have facility for this. Fourth, though sample size was done, it was small and a greater number of patients should be studied.

Conclusion

The results of our study lead us to conclude that frequent blood sugar monitoring in neurosurgical patients receiving dexamethasone can be accomplished by glucometer method since it is easy, quick, economical, and reliable method. We, however, recommend further studies comprising of a greater number of patients with diverse pathology to validate our findings.

Authors' Contributions

J.S. was involved in conceptualization, designing, definition of intellectual content, literature search, clinical studies, experimental studies, data acquisition, data analysis, and manuscript preparation. R.B. contributed to conceptualization, designing, definition of intellectual content, literature search, clinical studies, experimental studies, data analysis, statistical analysis, manuscript editing, and manuscript review. S.S. contributed to conceptualization, designing, definition of intellectual content, literature search, clinical studies, experimental studies, data acquisition, statistical analysis, and manuscript preparation. R.B. has provided guarantee to the manuscript.

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None.

Conflict of Interest

None declared.

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