

Comparison of blood glucose concentrations from capillaries and veins in SMBG*

(자가혈당측정시 채혈방법에 따른 혈당치의 비교)

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I. Introduction

With the outstanding improvement in medical technology, health service consumers became more and more get the control of their own bodies. This is especially important for the clients suffering from chronic illnesses like diabetes. But in order to create the most beneficial outcome for these technological developments, more accurate guidelines for their operations should be given for the users of these devices.

In considering that insulin self administration totally depends upon SMBG in community-base, health care professionals must be able to fully understand and to give guidelines for their clients, so as to the clients be effective in promoting and maintaining self care behavior(Gu Meeock, 1996).

In order to be utilized in preparing guidelines for the DM patients in self monitoring of blood glucose (SMBG), this clinical trial directly compared blood samples obtained by three different methods in the same subjects.

II. Literature Review

Blood glucose level is the most important landmark not only in diagnosing but also in treating and managing diabetes mellitus(DM)(The Diabetes Control and Complications Trial Research Group, 1993). Patients with DM had had to visit hospitals in order to take this test, but for the past decade self-monitoring of blood glucose (SMBG) has become a major adjunct to the care of individuals with DM. It is now possible for the diabetic patients and health care personnel to measure and record blood glucose level frequently with newly developed devices that are convenient to use and readily available (American Diabetes Association, 1987). Now SMBG is an essential component of any intensive insulin program directed toward achieving near-normo-glycemia, of which can be thought to be the realistic therapeutic goal in managing DM(American Diabetes Association, 1987). Even though it has many benefits and conveniences, the accuracy of SMBG is being questioned sometimes.

In general, following factors are thought to affect the accuracy and precision of SMBG. User varia

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bility : the major source of variability in results obtained with SMBG devices is attributable to the user. In contrast to the satisfactory accuracy and precision of the systems under controlled laboratory conditions, up to 50% of the values may vary more than 20% from the reference values in general use. Some of these user variables are 1) size and placement of the blood sample, 2) timing of the test, and 3) removal of blood from strip (American Diabetes Association, 1987). But in general, results are obtained with instrument read strip. Hematocrit is thought to affect markedly to the values of blood glucose, the magnitude of this effect may vary 40-30% for every 10% change in hematocrit, depending on the system used (American Diabetes Association, 1993). Severe hyper or hypoglycemia may cause unreliable SMBG. Instrument malfunctioning and defective reagent strips are the factors which may also affect SMBG results.

As for the physiology of blood glucose concentrations, there exists only a few references which mentions about the differences in blood concentrations from various sites of the human body. According to Kann & Weir(1994), the difference between the blood glucose concentrations from vein and capillaries is less than 1.1mg/dl. But Sternberg F. et al. (1995) found subcutaneous glucose as low as about 30mg/dl than in veins in their study with ten healthy volunteers. And also there is little notion on how to treat the specimens collected by some devient techniques. Books that even didn't clarify the differences, so it has been very hard for the practioners to give clear assurances in SMBG outcomes for their clients (Sternberg F., Meyerhoff C., Mennel J.F., Bischof F., Pfeiffer F.E., 1995 ; Kahn R.C., Weir G., 1994).

III. Materials and Methods

From 30 healthy (without DM) Korean men, who agreed to be included in this study, periperal blood and veinous blood was collected for the measurement of blood glucose levels. To clear out the

influences of collecting techniques, peripheral blood specimens were collected by three different methods. Firstly after pooling the peripheri of one finger, puncture was done and blood specimens were collected. Each methods were done two times. All the participants had been checked their blood glucose before their meals.

The blood glucose levels were measured by using the Glucocard (KDK Corp. Japan, 1995).

Data was summaried with means and then analysed using paired t-test, after validated the normal distribution. Pearson Correlation and Coefficiency was also used to clarify the relationship between the methods of sampling.

IV. Results

The blood samples obtained from the antecubital veins showed higher levels of blood glucose than from capillaries (Table 1 & 2).

When the antecubital venous samples were compared with the samples obtained after pooling the capillaries, the former (117.52 ± 55.62 mg/dl) were significantly higher by 8.5mg/dl ($t=2.86$, $p=.0081$) than the later (109.07 ± 53.99 mg/dl). And also, compare to the samples obtained by squeezing the capillaries after puncturing, the blood glucose concentrations

Table 1. Blood Glucose Levels. (N=30)

	Venous(mg/dl)	Capillary(mg/dl)	
		after pooling	by squeezing
Mean \pm SD	117.52 ± 55.62	109.07 ± 53.99	107.62 ± 54.48
Minium	73	63	74
Maxium	166	165	158

Table 2. Comparision of Blood Glucose Levels

	Venous	Capillary (pooling)	Capillary (squeezing)
Venous		$t=2.86^{**}$ $p=.0081$	$t=3.08^{**}$ $p=.0055$
CA(pooling)			$t=0.72$ $p=.4791$

(** statistically significant at the level of $p < .05$)

(107.62±54.48mg/dl) were significantly lower by 9.9mg/dl than venous blood ($t=3.08$, $p=.0055$).

As for the techniques when collecting samples (Table 2 & 3), after pooling and squeezing were not just same as each other ($R=.9632$, $p=.0001$), their difference had no statistical significance ($t=0.72$, $p=.4791$).

Table 3. Correlation between the blood glucose levels from vein and capillaries.

	Venous	CA(pooling)	CA(squeezing)
Venous	$R=1.0000$ ($p=.0000$)	$R=.9600^{**}$ ($p=.0001$)	$R=.9678^{**}$ ($p=.0001$)
CA(pooling)		$R=1.0000$ ($p=.0001$)	$R=.9632^{**}$ ($p=.0001$)

(Pearson Correlation Coefficient was used,

** statistically significant at the level of $p<.05$.)

V. Discussions

SMBG is a tool used by both health care providers and patients to monitor effectiveness of their therapies of DM. So it is important that qualified health care providers and trained have accuracy in this technology, as most of the errors in this process may lead to a mismanagement of DM. This study aimed to find out how the blood glucose concentrations are different from collecting sites and methods.

Only several authors had had interests in blood glucose concentrations in various body sites. And their findings or statements do not agree. With all these discrepancies of literatures, generally, the blood in vein is thought to be higher than the blood in capillaries. According to Kann & Weir(1994), the difference between the blood glucose concentrations from vein and capillaries is less than 1.1mg/dl. But Sternberg F. et al.(1995) found subcutaneous glucose as low as about 30mg/dl than in veins in their study with ten healthy volunteers. In this study with healthy samples, their venous glucose concentrations were higher than the blood samples from capillaries by 8-10mg/dl, when monitored with a

SMBG machine(Glucocard).

The discrepancies between this trial and the other studies call for further investigations with more controlled setups in more controlled samples.

To collect specimens after pooling the capillaries can be said as a proper techniques in SMBG. But in practical situations, sometimes many health care professionals and clients find their samples not enough for the measurement, after puncturing the finger. At those situations, some people often tries for a second sampling. But this may cause undesirable influences for the clients. After all the limitedness of this clinical trial, the squeezing technique seemed to make no considerable differences between the technique which had been thought to be as proper. So if we fail to make the first puncture properly, we may squeeze the former sites for more amount of blood, if it is thought to be needed for the well-being of the health care consumers, not for the obsessive completions of the care professionals' practice.

VI. Conclusions

This clinical trial aimed to give a guidelines for the SMBG, which is no more a Greek concept to not only health care workers but also for the DM clients. From 30 healthy(without DM) Korean men, peripheral blood and venous blood was collected for the measurement of blood glucose levels, before their meals. To clear out the influences of collecting techniques, peripheral blood specimens were collected by three different methods. Firstly after pooling the periphery of one finger puncture was done and blood specimen was collected Each methods were done two times. The blood glucose levels were measured by using the Glucocard(KDK Corp. Japan, 1995).

The blood samples obtained from the antecubital veins showed higher levels of blood glucose than from capillaries(Table 1). When the antecubital venous samples were compared with the samples obtained after pooling the capillaries, the former were significantly higher by 8.5mg/dl($t=2.86$, $p=$

.0081) than the later. And also, compare to the samples obtained by squeezing the capillaries after puncture, the blood glucose concentrations were significantly low by 9.9mg/dl then venous blood($t=3.08$, $p=.0055$). The discrepancies between this trial and the other studies call for further investigations with in more controlled settings with more controlled samples.

After all the limitedness of this clinical trial, the squeezing technique seemed to make no considerable differences between the technique which had been thought to be as proper. So if we fail to make the first puncture properly, we may squeeze the former site for more amount of blood and then put it on the test strip, if it is thought to be needed for the well-being of the health care consumers, not for the obsessive completions of the care professionals' practice.

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- 국문초록 -

주요개념 : 혈당치, 자가혈당측정

자가혈당측정시 채혈방법에 다른 혈당치의 비교

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당뇨병환자의 자가혈당 조절에 있어서의 기준이 되는 혈당측정에 있어서 하나의 지침을 제공하기 위해 본 연구는 말초혈관과 상완정맥에서의 혈액을 채취하여 이들 검사물들의 혈당치를 직접적으로 비교했다.

30명의 건강한 한국인 성인 남자(연령; 평균=30세)로부터, 공복시의 혈액을 세가지의 서로 다른 방법들(수선 큰가닥 끝에 말초혈관을 출혈이 되도록 한 뒤에, 이후 같은 편의 팔의 상완정맥에서, 마지막으로 다시 처음 검체를 시행했던 바로 그 말초의 천자부위에서 혈액을 짜내는 방법으로.)로 각각의 대상에서 검체하였다. 검사물들의 혈당치는 간편측정용 혈당측정기(Gluco-card, KDK Corp., Japan, 1995)로 측정된 결과 상완정맥에서 채취한 혈액의 혈당치($107.58 \pm 21.03\text{mg/dl}$)가 말초에서 채취한 혈액(출혈 후: $100.21 \pm 24.03\text{mg/dl}$, 짜낸 경우: $97.84 \pm 22.45\text{mg/dl}$)들 보다 높았다($T=2.86$, $p=.0081$; $T=3.084$, $p=.0055$). 그러나 이 결과는 기타의 연구들에서의 결과와는 일치하지 않았다. 이러한 불일치는 자가혈당측정기가 인슐린 의존형 당뇨병환자는 물론이고 비의존성 당뇨병환자들의 자가관리에 결정적인 시점이 된다는 점을 고려할 때, 좀 더 통제된 상황에서 더욱 많은 사람을 대상으로 한 임상시험을 통해 자가혈당측정법에 있어서 기계요인에 대한 분석이 이루어질 필요를 시사하고 있다.

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또한 동일한 부위에서 서로 다른 방법들(혈관을 울혈을 시킨 천자하여 얻은 경우와 천자 후 그 부위를 짜서 검사물을 얻는 방법)에 의해서 얻어진 혈액의 혈당치 측정 결과 간에 차이가 없는 것으로 나타나서($t=0.72$, $p=.4791$), 일반적으로 혈당치의 측정 시 검체한 양이

부족할 때, 새로이 천자하여 검사를 시행하는 것을 원칙으로 인식하고 있으나 본 연구결과를 볼 때, 이러한 채혈의 방식에 의한 차이는 환자의 안녕의 차원에서 고려하여 필요하다면 간과될 수도 있음을 의미하고 있다.