Monitoring Blood Glucose by Linearly Split Glucostix

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ABSTRACT

The blood sugar in forty four samples taken from thirty two fasting diabetic patients were determined visually using half linearly split and complete Glucostix strips by two independent readers. When the change of colour on the standard strips were compared with the corresponding linearly split ones, the correlation coefficients were 0.97 and 0.92 for each reader. Thus, splitting the standard Dextrostix strip linearly into two halves doubles the number of readings achieved from each canister.

Involving patients in monitoring their disease improves compliance[1]. Diabetic patients are no exception to the rule.[2, 3] Although many diabetics continue to perform at least some urine testing; however, this is not nearly as helpful or as accurate as self monitoring of blood glucose.[4,5]

Two popular methods for home blood glucose monitoring are available; namely, the test strip for visual determination of blood glucose, and the reflectance meter. The latter is relatively expensive and can be seriously inaccurate at times.[6] In addition to this, many diabeticians have shown that there is no significant difference between the two methods if the patient is well trained to process and read the glucose reagent strip.[4, 7-13]

Some diabetic patients who use the visual method in monitoring their blood glucose are used to cut the strip linearly into two halves for the purpose of decreasing the cost. In the absence of such a recommendation by the manufacturer, one would wonder if such an action would affect accuracy of the result.

This study was designed to answer this question by using Glucostix (Ames Division, Miles Laboratories, Slough, England).

METHODS

For this purpose 44 samples of venous blood were taken from 32 fasting diabetic patients attending Naim Health Centre laboratory in Manama, Bahrain during the second half of August, 1989. The humidity and temperature of the environment in which the study was done, were maintained at 63% and 24°C respectively. The linearly split strips were prepared by cutting the standard strip linearly in half using an ordinary stainless steel scissors. A drop of blood from each sample was placed on a complete and linearly split Glucostix strip. The strips were processed by two laboratory technicians in the absence of the readers who were not aware of any relation between the complete and split strips. The manufacturers' instructions were followed closely in processing and reading the samples. To decrease the possibility of bias in reading the strips, not less than 6 strips were prepared at one session. The maximum number of strips processed were twelve. Each set of strips included the corresponding complete and linearly split strips. The total sets read were 11 sets; three of them contained 6 strips; six contained 8 strips; one, 10 strips; and one, 12 strips. The readings against the colour scale provided on the Glucostix canister was carried by two medical doctors with no visual defect (normal colour vision and visual acuity). Furthermore, the two doctors were well trained at reading the Glucostix. The readers determined the change of colour intensity of the strips independently, and without knowledge of the other results. The delay in reading the strips

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TABLE 1

Blood glucose concentrations estimated by two readers using standard and split Glucostix strips.

	First Reader		*Second Reader*	
Blood Sample No	*Standard Strip (mmol/l)*	*Linearly split Strip (mmol/l)*	*Standard Strip (mmol/l)*	*Linearly split Strip (mmol/l)*
1	8	8	8	8
2	14	14	14	14
3	8	8	8	8
4	14	14	14	14
5	8	8	10	10−
6	8	8	10	10
7	10	10	10	10
8	6	8	8	8
9	14−	14−	14−	14−
10	22	22	22	22
11	14	10+	14	14
12	8	8	8	10−
13	22	22	22	22
14	8+	10	10	10+
15	14	14	22−	22
16	14	22−	22−	22
17	4	4	4+	6−
18	10+	10	10+	10+
19	44	44	44−	44−
20	8	8	8−	8
21	10	10	14	14
22	22	14+	22	22
23	8−	8−	8	8
24	44−	44	22+	44−
25	8	8	8	8
26	8	8	8	8
27	22−	22	22	22
28	14	14	14	14
29	8	8	8	8
30	10+	10+	14−	14−
31	8	8	8	8
32	14−	14	14	14
33	8	8	10	10
34	14−	14−	14	14
35	8	8	8	8
36	14−	10+	14	14−
37	10	10	10	10
38	4+	4+	4	4+
39	4+	4+	4	4
40	10	10	10−	10
41	8	8	8	8
42	8	8	8	8
43	8	8	8	8
44	8	8	8	8

between the two observers varied from 30 seconds to 60 seconds were allowed to interpolate their reading by putting a plus or minus sign if the colour determined against the manufacturers' colour scale is darker or lighter, respectively, and does not match any of the colours displayed on the scale given on the canister. The correlations between the readings determined by the linearly split and standard strips were assessed by linear regression analysis and expresed as r.

RESULTS

The readings of the standard and linearly split strips for the first and second readers are shown in Table 1. When the readings of the linearly split strips were compared with those determined by the complete strips, the coefficients of correlation were 0.97 and 0.92 for the first and second readers respectively, without interpolation (Fig 1 & 2).

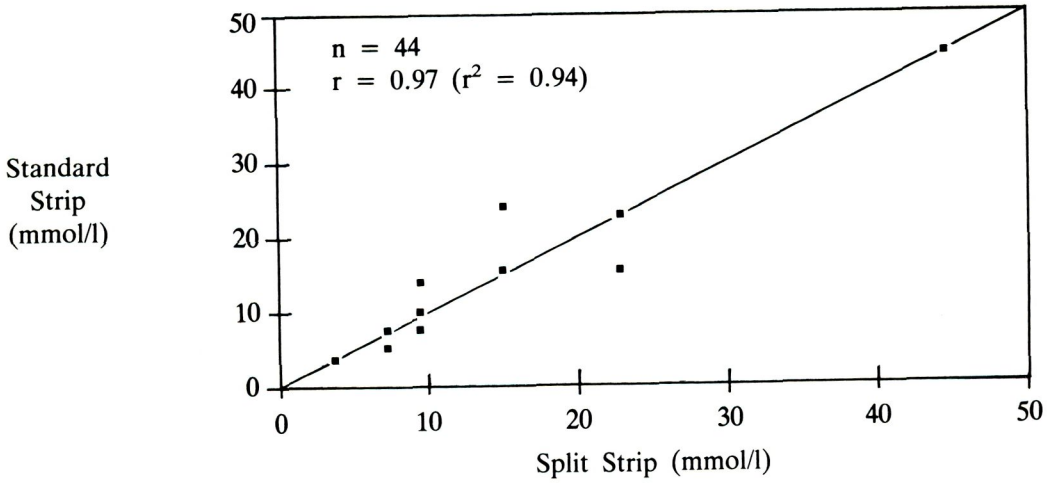

Figure 1 First Reader – Correlation between serum glucose concentration readings of standard and linearly split Glucostix strips

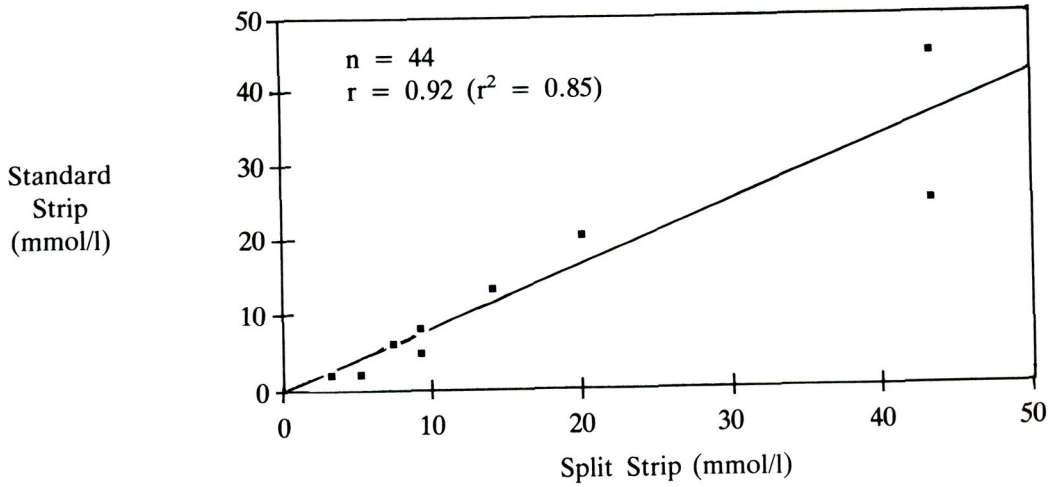

Figure 2 Second Reader – Correlation between serum glucose concentration readings of standard and linearly split Glucostix strips

When the readings of the 1st and 2nd readers were pooled together, the coefficient of correlation became 0.94 (Fig 3).

The correlation between the two doctors' readings were 0.88 for the complete strips and 0.97 for the linearly split strips (Fig 4 & 5).

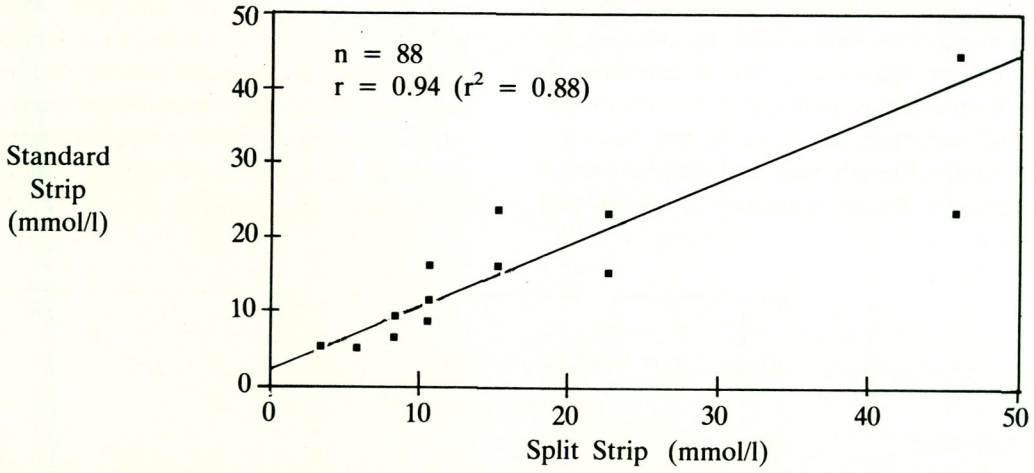

Figure 3 Both Readers – Correlation between serum glucose concentration readings of standard and linearly split Glucostix

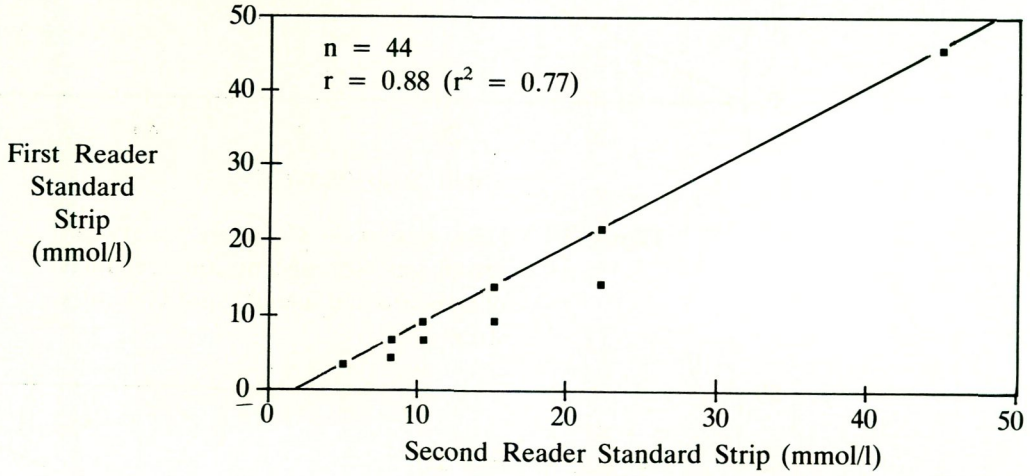

Figure 4 – Correlation between serum glucose concentration readings of standard Glucostix strips by the two readers

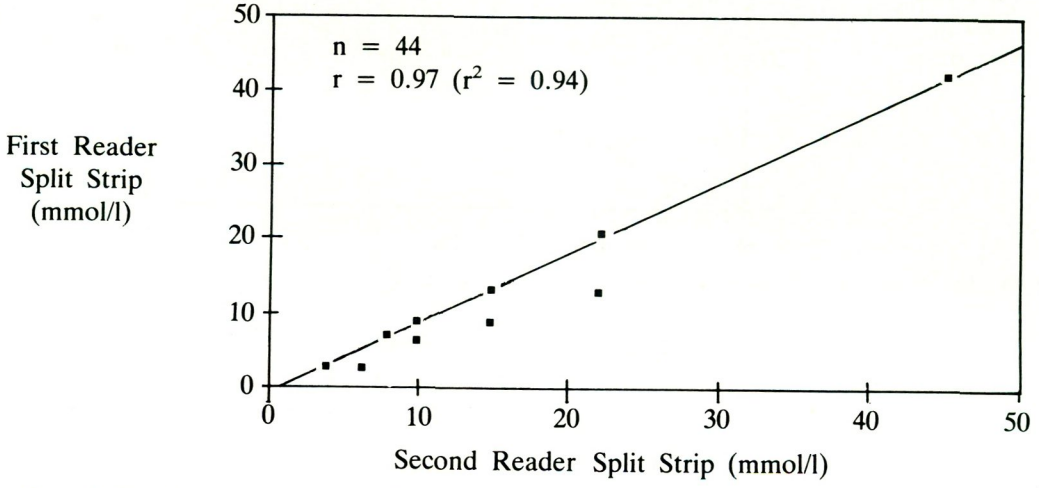

Figure 5 – Correlation between serum glucose concentration readings of linearly split Glucostix strips by the two readers

DISCUSSION

The difference in the colour change between some of the linearly split and complete strips in this study may be attributed to the fact that the corresponding strips were not read at the same time. Even a delay of 10 seconds in reading a Dextrostrix or a Reflotest glucose results in underestimations of 6.8 ± 1.5% and 3.9 ± 0.7%, respectively.[14] This may also hold in the case of Glucostix strips. Such a delay could not be avoided since the readers were always given at least six strips at a time for reading. The same argument holds for the differences observed between the two readers in reading the strips.

A look at the blood glucose levels determined by the linearly split and the corresponding standard strips shows that only in 21 instances the readings did not coincide. Furthermore, it is observed that in 15 of the 21 readings, the higher determinations were on the linearly split strips. This may be explained by the fact that a more homogeneous spread of a blood drop is achieved on a smaller reagent pad which results in a more even colour change.[14].

In addition, an important factor that affects the correlations determined in a negative way is that in the wide range of 14 mmol/l – 44mmol/l* there are only 3 colour steps; thus, a difference by one colour step between two comparable strips will place such a reading far away from an ideal regression line.

Inspite of what was mentioned, the correlations between the blood glucose estimated by the split and the complete strips were very good. Yet, it has to be realized that such an otucome was achieved by medical doctors, who are well trained at reading the glucostix strip. Training, therefore, is essential if results are to be reliable.

CONCLUSION

One of the goals of treatment is to prevent chronic complications in patients with diabetes mellitus. This goal may be achieved by maintaining a strict control of the blood glucose level.[15-17] Home blood glucose monitoring (HBGM) helps patients in maintaining a tight control over their plasma sugar; however, cost of the method used for HBGM may affect compliance to such techniques. A reflectance meter is relatively expensive (ranging from US$170 to US$350), more difficult to use and has more sources of errors when compared to blood sugar determination by the reagent strip method. Other shortcomings of reflectance meters include limited portability and the possibility of mechanical breakdown.

On the other hand, one canister of Glucostix contains 25 strips at a cost of around US$15. This study proves that by splitting the standard Glucostix strip in two, the number of readings achieved from each canister can be doubled without affecting the reliability of the reading. Furthermore, using a linearly split reagent strip decreases the area of the reagent pad thus making it easier to cover by a small drop of blood; this eliminates an important source of error in reading the glucose reagent strips.[14, 18]

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* The colour blocks found on the Glucostix label correspond to 1, 2, 4, 6, 8, 10, 14, 22 and 44 mmol/l.

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