Opportunities of the Akabane Test for Diagnosis and Monitoring of Patients with Type 2 Diabetes

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Abstract

Background: In view of its prevalence, type 2 diabetes (T2D) is a socially significant disease, which affects millions of patients. Despite the significant advances in modern medicine, there are problems with early diagnosis and effective treatment of this disease, especially at home. In this regard, it would be interesting to pay attention to the possibility of diagnosing and treating this disease from reverse the viewpoint of traditional Chinese medicine (TCM).

Methods/Design: In order to assess patterns of heat sensitivity thresholds of acupuncture channels (AC) in patients with T2D, the Akabane test was carried out on with 116 men and 190 women. For comparison, a group of healthy subjects made up of 112 men and 277 women was also used.

Results: Simple effects of paired comparisons between healthy subjects and T2D in groups of men and women, showed significant differences. The most significant differences are seen in the AC connected with the digestive system. In this case, the greatest diagnostic value is the level of asymmetry between the right and left branches of these AC, which varies in proportion to the level of glycaemia. Changes in the AC are stable and precede the manifestation of the functional and organic disorders inherent in this disease. This dependence allows for early T2D diagnostics and individual monitoring.

Conclusion: The combination of the Akabane test with the use of mathematical analysis in patients with T2D makes it possible to trace the entire chain of carbohydrate metabolism at an individual level and to identify regulatory violation and the compensatory mechanisms for more effective therapeutic effects.

Keywords: Akabane test; Type 2 diabetes; Hyper and hypoglycemia; Evaluation of compensatory mechanisms; Pain; Telemedicine
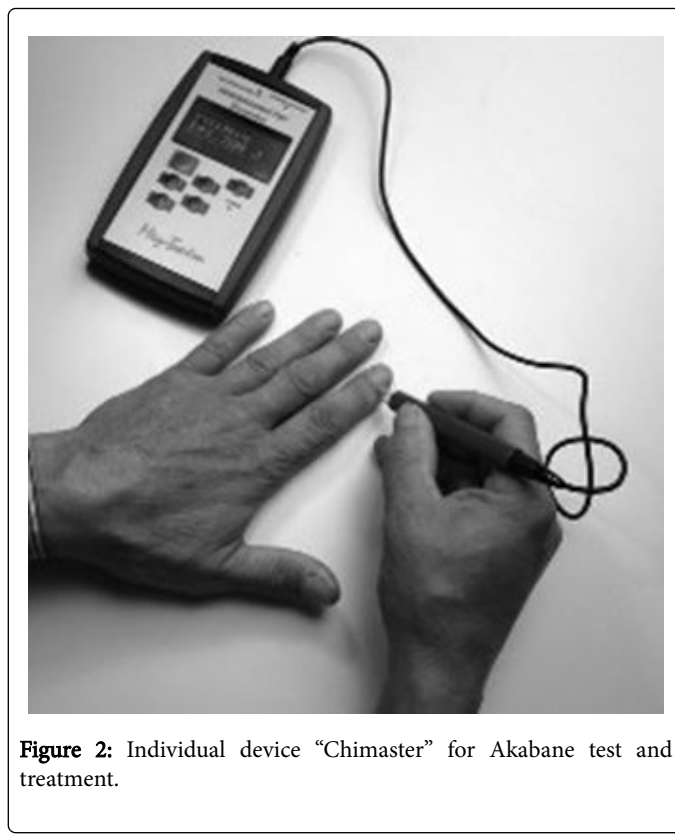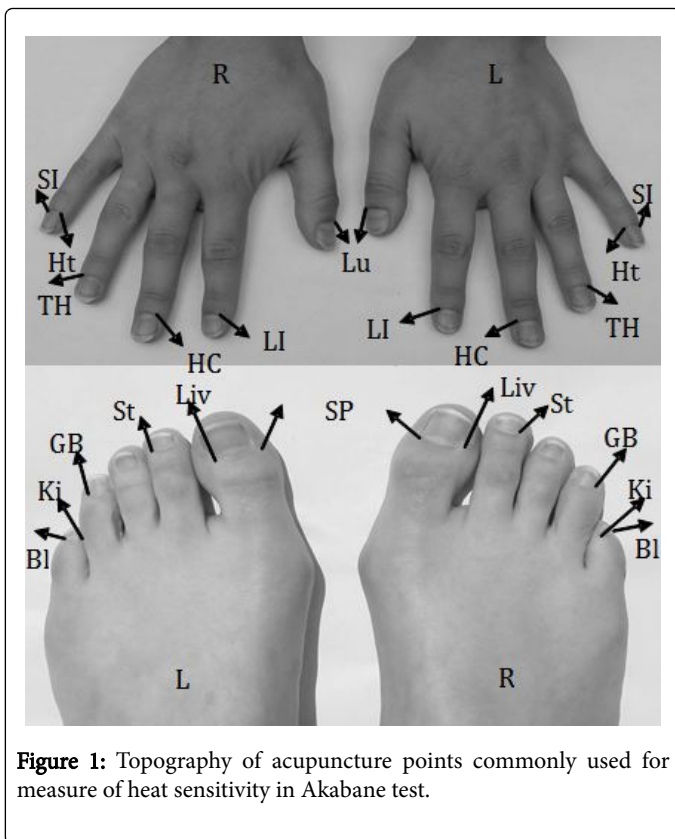
Introduction

In view of its prevalence, diabetes mellitus is a socially significant disease which has become akin to a pandemic, especially in recent years. According to the World Health Organization diabetes affects more than 14% of the total population of the globe, while a normal level of sugar in the blood is marked only in 76% of the population. However, despite important achievements in this field, it still has not been possible to reverse the situation in terms of its early diagnosis and effective treatment.

Main observation method for this kind of patients is real time monitoring of blood sugar level [1-5]. However, the glucose level of blood is only an end product in many-linked chain of energy metabolism in an organism, involving many organs and systems. With monitoring at this stage, high blood sugar is only a fait accompli, and there is no opportunity to trace on which level the individual regulatory failure has happened in order to provide targeted medical correction. Despite the use of various technical systems, this problem is still a leading one in reasonable treatment.

Adage goes that there is nothing new except what has been forgotten. In this regard, it would be interesting to pay attention to the possibility of diagnosing and treating this disease from the viewpoint of traditional Chinese medicine (TCM) and acupuncture, which has existed for more than 2000 years and accumulated vast experience in the diagnosis and treatment of a wide variety of diseases including type 2 diabetes [6-11]. According to TCM, effectiveness of such treatment methods depends directly evaluation of energy level in acupuncture channels (AC).

In order to quantitatively evaluate a channel's energy activity level in TCM, the so-called "sacrificial stick" test was used in ancient times in China. This test involved a burning sandal stick which was brought in time with the pulse in proximity to specific diagnostic points at the tips of finger and toe until the first sensation of pain (Figure 1).

Figure 1: Topography of acupuncture points commonly used for measure of heat sensitivity in Akabane test.

Figure 2: Individual device "Chimaster" for Akabane test and treatment.

At each point, calculated by the number of heat passes before was first feeling the pain. If the number of heat passes was lower than the average one for all the channels, it proved the hyperactivity of an acupuncture channel and its corresponding organ. On the other hand, when the number was higher, it represented the inactivity of a channel and its corresponding organ. This test was described by the Japanese doctor Koben Akabane in 1952 [12].

Since then, the test has carried his name, and numerous devices for the test of temperature sensitivity thresholds (TS) have been elaborated all over the world. The increased accuracy of evaluation using TS and the repeated accuracy of the method are used in connection with the fact that as humans are warm-blooded creatures, they have a highly-developed system for measuring temperature, down to one hundredths of a degree.

From the view of modern physiology the idea of channel energy is equivalent to notion of functional activity of organs, connected to each of these channels. So, as a result of 3-5 minute test we get digitally coded information of individual functional activity of main organs and systems of a body which participate in carbohydrate metabolism. It provides new opportunities for monitoring this kind of patients, in particular domiciliary, as this test can be performed by patients themselves.

Materials and Methods

In our study we used a special certified individual device "Chimaster", invented by Muzhikov (Figure 2) [13]. This test measures the pain TS when heat is applied to the "entrance-exit" points which are traditionally examined in acupuncture to evaluate the channels: LU11, LII1, PC9, TE1, HT9, SI1, SP1, LR1, ST45, GB44, KI1, and BL67 (Figure 1) by applying an impulse LED non-coherent IR-light onto the skin (f=1Hz, λ=920nM), with control the total energy expenditure in Joules. Each impulse radiates 0.07 Joule thermal energy.

In order to assess patterns of TS in patients with diabetes mellitus, the Akabane test was carried out on patients with T2D (116 men and 190 women). The diagnosis of diabetes mellitus was confirmed on the basis of standard examination methods in a specialized endocrinology hospital clinic environment. The average age of the patients was 56.80 ± 11.2 years. For comparison, a group of healthy subjects of 112 men and 277 women was also used. Patients with polyneuropathy were excluded from the study. Simultaneously with the test Akabane an analysis of capillary blood from the finger was carried out on all patients using an individual glucometer for sugar levels on an empty stomach in the morning before taking medications. In statistical sampling for each patient was taken no more than two tests, which were conducted on different days. The study included patients with a sugar level of 4.2 to 18.4 mmol/l.

According TCM and our study results [14,15] the following channels have different regulatory functions:

LU-lungs channel, connected with the function of lungs and tissue breathing.

Li-large intestine channel, connected with the large intestine function and its microbe flora, it participates in the regulation of arterial pressure, biochemical blood indices.

PC-pericardium channel, connected with the cardiac muscle trophicity and its structure. In addition, it is connected to muscular activity, arterial blood pressure levels and emotions.

TE-triple heater channel, connected to the central and peripheral hemodynamic, and regulates thyroid and hypophysis hormones in the body,.

HT-heart channel, regulates the cardiac rhythm, body's physical strength

Si-small intestine channel, connected to the electrolytic balance and food digestion.

SP-spleen-pancreas channel is connected to the pancreas and immunity.

LR-liver channel is connected to liver function and central nervous system, stress levels

St-stomach channel is connected to the digestion function.

GB-channel of the gallbladder is connected to the digestion function and peripheral nervous system.

Ki- kidney channel is connected to the kidney function and the sympathoadrenal system.

BL- urinary bladder channel is connected to the urogenital system, its functions and its related hormones.

As follows from this short list, each AC can reflect various physiological and biochemical body indicators in addition to basic links with certain organs and physiological systems. Each channel has 2 branches - left (l) and right (r), and in a healthy person they are in the state of energetic balance.

All data are presented as mean ± SEM. One-way MANOVAs followed by Bonferroni post hoc tests and testing simple effects were used to analyze the effect of gender (Males/Females) and of pathology factors (healthy people-Norm and patients with T2D) on the profiles of TS, with an evaluation of simple effects related to gender and pathology. In addition, the profiles of TS were compared using Mann-Whitney test. Statistical decisions were made at a significance level of 5% (p ≤ 0.05). Data analysis was provided using software package SPSS Inc. V 15.

Results

Figure 3 shows the TS profiles at 12 AC level in patients with T2D in comparison with a norm. In general, a significant difference in TS profile in comparison with a norm is noted, especially for AC level, associated with the digestive and hormone systems. Almost the same values of TS are noted for AC level, associated with cardiovascular system. The minimum variation (deviation) of the values is identified there. In contrary, the maximum differences between T2D and a norm are identified in male patients at AC- SP, LR, ST and BL a level and in female patients at AC- LR and SP. According to TCM the high TS values obtained through the test reflect the "energy emptiness in the channels". Therefore, it corresponds to the hypo-function of organs and systems, associated with this channel, being proportional to the increase of their TS values.
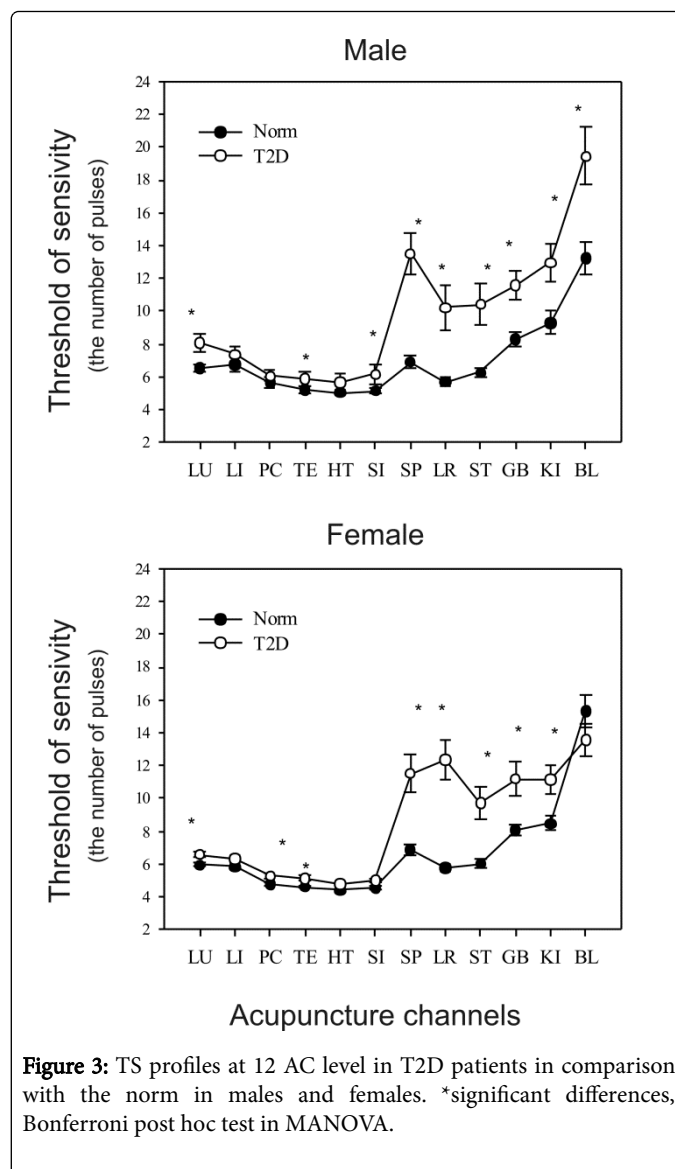

Figure 3: TS profiles at 12 AC level in T2D patients in comparison with the norm in males and females. *significant differences, Bonferroni post hoc test in MANOVA.

Table 1 shows the results obtained when the healthy subjects and those with T2D at the level of 12 AC were compared using Post hoc tests in MANOVA and the Mann-Whitney test.

AC	Male		Female	
	Post hoc tests	M-W	Post hoc tests	M-W
LU	*** <0.001	**0.003	*0.050	*0.010
LI	0.204	0.073	0.214	*0.019
PC	0.208	0.112	*0.049	*0.023
TE	*0.045	0.083	*0.034	**0.002
HT	0.068	0.925	0.154	0.087
SI	*0.013	0.597	0.153	*0.024
SP	*** <0.001	*** <0.001	*** <0.001	*** <0.001
LR	**0.001	**0.002	*** <0.001	*** <0.001

ST	**0.001	**0.004	*** <0.001	*** <0.001
GB	**0.006	*** <0.001	*** <0.001	0.507
KI	**0.004	**0.001	**0.005	**0.007
BL	**0.001	*0.016	0.222	0.605
Note. * p<0.05, ** p<0.01, *** p<0.001, + tendency.				

Table 1: Comparison of TS profiles of 12 AC between the Norm and T2D.

Main effects in 2X2 MANOVA are significant for both Gender, $F_{(12.635)}=2.48$, p=0.003, $\eta^2=0.045$ and Diagnosis, $F_{(12.635)}=5.96$, p<0.001, $\eta^2=0.101$. Interaction of factors Diagnosis and Gender show significance, $F_{(12.635)}=1.9$, p=0.028, $\eta^2=0.035$.

Almost all channels demonstrate the significant differences in variance between a norm and T2D but the maximum differences in men marked by the as the lungs (LU) and pancreas (SP). Women are highlighted as the digestive system.

The study at the level of 24 branches of 12 AC (Figure 4) allowed to reveal another additional important difference of T2D from the norm, but they more details confirm previous addiction.
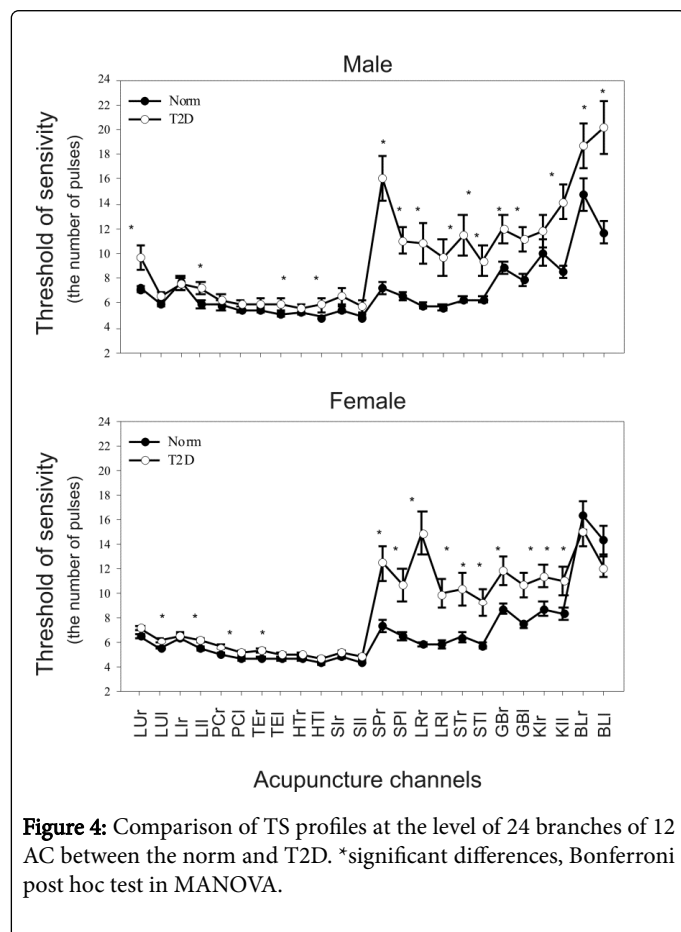

Figure 4: Comparison of TS profiles at the level of 24 branches of 12 AC between the norm and T2D. *significant differences, Bonferroni post hoc test in MANOVA.

Table 2 shows the results obtained when the healthy subjects and those with T2D at the level of 24 branches of 12 AC were compared using Post hoc tests in MANOVA and the Mann-Whitney test.

Dependent variables-factors-Gender (males/females) & Diagnosis (Norm/T2D).

AC	Male		Female	
	Post hoc tests	M-W test	Post hoc tests	M-W test
LU r	*** <0.001	***0.001	0.178	0.06
LU l	0.082	0.266	*0.025	0.032
LI r	0.912	0.66	0.683	0.182
LI l	**0.005	**0.004	*0.041	0.001
PC r	0.223	0.092	*0.049	0.026
PC l	0.258	0.268	0.088	0.11
TE r	0.131	0.215	**0.009	*** <0.001
TE l	*0.025	0.137	0.16	0.085
HT r	0.482	0.753	0.197	0.258
HT l	**0.009	0.714	0.162	0.052
SI r	0.021	0.868	0.285	0.052
SI l	0.017	0.484	0.089	0.02
SP r	*** <0.001	*** <0.001	*** <0.001	*** <0.001
SP l	**0.002	0.001	*** <0.001	0.013
LR r	**0.007	0.003	*** <0.001	*** <0.001
LR l	**0.006	0.004	*** <0.001	*** <0.001
ST r	**0.001	0.006	**0.001	0.058
ST l	*0.012	0.088	*** <0.001	***0.001
GB r	*0.031	0.011	0.006	0.882
GB l	**0.006	*** <0.001	*** <0.001	0.173
KI r	0.245	0.055	*0.018	**0.002
KI l	*** <0.001	**0.002	*0.016	0.066
BL r	0.079	0.099	0.457	0.247
BL l	*** <0.001	**0.002	0.155	0.504
Note. *p<0.05, **p<0.01, ***p<0.001, +tendency.				

Table 2: Comparisons between Norm and T2D at the level of 24 branches of 12 AC.

Main effects in 2 × 2 MANOVA are significant for both Gender, $F_{(24.623)}=1.94$, p=0.005, $\eta^2=0.07$ and Diagnosis, $F_{(24.623)}=4.3$, p<0.001, $\eta^2=0,143$. Interaction of factors Diagnosis and Gender show significance $F_{(24.623)}=1.95$, p=0.005, $\eta^2=0.07$.

According to the study results there are significant differences in variance between a norm and T2D in almost all AC, associated with a gastrointestinal tract, provided that the quantity of the significant differences in female patients is much bigger in comparison with male patients. At males and females, the greatest difference marked by the right branch of SPr. However, in males also the maximum difference

observed on the LUr, and females in both branches of the liver (LR) and the left branches of the stomach (STl) and GBl.

T2D profiles show the dominance TS level of the right branches of the AC over the left branches. As a result, Right/Left (R/L) ratio is the most effective criteria for evaluation of the body functional status. This is confirmed by the results of previous studies [16,17]. Figure 5 shows these profiles of the R/L ratio in T2D comparing to the norm. The diagrams show that the R/L ratio is always higher than 1.0 even in terms of the norm. Patients T2D this ratio according to some AC exceeds the "Golden index" of asymmetry in 1.62 that does not find the explanation from the point of view of the theory of nervism where the right and left symmetrical diagnostic point must have the same parameters TS. Moreover, it is precisely those that are most associated with the formation of T2D.
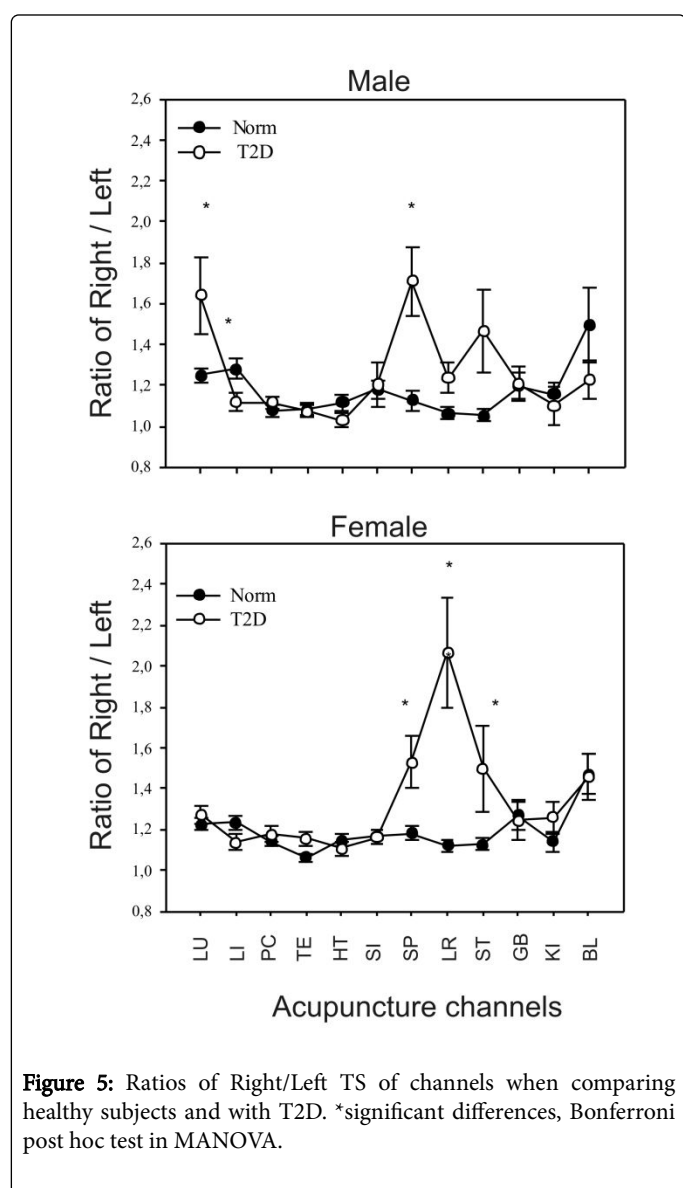

Figure 5: Ratios of Right/Left TS of channels when comparing healthy subjects and with T2D. *significant differences, Bonferroni post hoc test in MANOVA.

The most significant differences with the norm in these TS profiles are noted in male patients in AC at LU, LI and SP points, and in female patients in AC at SP, LR and ST points. These results also evidence the more pronounces clinical damages at T2D in male patients associated

with lungs, indicating the tissue hypoxia in comparison with female patients. On the other hand, in female patients the biggest differences with a maximum asymmetry on the channel of the liver are stated.

Some channels are characterized by the significant differences in variances between a norm and a diabetes condition, which are not indicated at the diagram. In particular, according to the Mann-Whitney test (Table 3) the differences were found in male patients at AC-LU, LI, HT, SP, KI and BL levels and in female patients at AC-LI, TE, SP, LR and ST levels. In norm ratios of R/L is practically the same in male and female.

AC	Male		Female	
	Post hoc tests	M-W	Post hoc tests	M-W
Ratio_LU	**0.002	0.119	0.619	0.753
Ratio_LI	*0.015	**0.006	0.053	*0.050
Ratio_PC	0.467	0.27	0.414	0.945
Ratio_TE	0.803	0.542	**0.009	0.076
Ratio_HT	0.13	*0.037	0.357	0.345
Ratio_SI	0.773	0.457	0.952	0.597
Ratio_SP	*** <0.001	**0.003	**0.004	0.028
Ratio_LR	0.493	0.585	*** <0.001	0.222
Ratio_ST	0.071	0.417	*0.028	*0.047
Ratio_GB	0.946	0.079	0.821	0.128
Ratio_KI	0.618	*0.013	0.168	0.485
Ratio_BL	0.171	*0.030	0.929	0.089

Note: *p<00.050. **p<00.010. ***p<00.0010. + tendency.

Table 3: Paired comparisons between Norm and T2D at the level ratios of Right/Left TS of channels.

Main effects in 2×2 MANOVA are significant for both Gender, $F_{(12.635)}=2.0$, $p=0.02$, $\eta^2=0.037$ and Diagnosis, $F_{(12.635)}=4.86$, $p<0.001$, $\eta^2=0.084$. Interaction of factors Diagnosis and Gender did not show tendency, $p=0.052$. Males-Females posthocs test in the relations R/L with T2D was detected in only 2 differences in the channels LU $(p=0.001)$ and LR $(p<0.001)$.

Table 4 contains correlations of AC with fingertip blood sugar levels. Males have only 2 positive (+) links to the left branch of AC of pancreas (SPl) and stomach (STl). Also there is a tendency $(p=0.51)$ in connections with the right branch AC of small bowel (SIr) that is quite logical. Female have significantly more positive connections, they are all marked with (-) link vector connections to the glucose level and in most cases with right branch of LIr, PCr, TEr, Sir and KIr channels, which is quite remarkable. There is only one connection with the AC-BL left branch that reflects sexual endocrine profile. Such difference between males and females can be explained by the fact that the right (Yin) branch of AC is involved in energy accumulation, while the left (Yang) - in its spending. This is responsible for general difference in right-side asymmetry of liver point values against R/L. This is the reason why the male glycemic level depends more on physical activity while the female one-on its abnormal accumulation over little wastes.

This conclusion is confirmed by difference between glucose link vectors: in males high liver point values with positive (+) link vectors correspond with low functional activity of these systems. Consequently, this situation causes glycemia level to go up. In females, however, high right branch AC values with negative (-) vectors of glucose links tend to cause decrease in its accumulation. In TCM females are Yin, and males are Yang. It also explains general difference in gender laterality of correlation dependencies, which are also exist in evaluation of other essential body indicators [14].

Glucose from the finger (Pearson Correlation)				
	Males		**Females**	
AC	**r**	**Sig. (2-tailed)**	**r**	**Sig. (2-tailed)**
LU r	0.093	0.356	-0.079	0.395
LU l	-0.149	0.138	-0.028	0.762
LI r	-0.051	0.616	-0.226(*)	**0.013**
LI l	-0.027	0.791	-0.152	0.1
PC r	-0.09	0.374	-0.263(**)	**0.004**
PC l	-0.117	0.245	-0.129	0.162
TE r	-0.065	0.518	-0.257(**)	**0.005**
TE l	-0.153	0.129	-0.159	0.085
HT r	-0.129	0.202	-0.175	**0.057**
HT l	-0.137	0.174	-0.119	0.197
SI r	0.196	**0.051**	-0.204(*)	**0.026**
SI l	-0.138	0.17	-0.051	0.581
SP r	-0.037	0.716	0.048	0.604
SP l	0.200(*)	**0.046**	-0.006	0.952
LR r	0.058	0.569	0.14	0.129
LR l	0.097	0.337	0.01	0.914
ST r	0.119	0.239	-0.039	0.675
ST l	0.219(*)	**0.029**	-0.026	0.782
GB r	-0.02	0.845	-0.154	0.095
GB l	0.05	0.622	-0.051	0.58
KI r	-0.043	0.672	-0.217(*)	**0.018**
KI l	0.111	0.271	-0.135	0.142
BL r	-0.076	0.454	-0.153	0.096
BL l	0.085	0.403	-0.202(*)	**0.028**
*p<0.05, **p<0.01, ***p<0.001				

Table 4: Correlation of capillary glucose from a finger with AC.

For individual monitoring of patients with T2D optimal is the construction regression dependencies of the channels with the target parameter. Thus on one side of the scale are the channels with (+) a vector of influence, and on the other with (-) vector influence. Thus it

can be seen which channels contribute the most regulatory influence in the increase or decrease of the studied parameter.

Table 5 shows the regression model of correlation between AC and fructosamine level in male patients. It should be noted that fructosamine has a different chemical formula than glucose, so the channels associated with it can have a different laterality and the vector interaction. In general, this model replicates the previous correlations (SI, SP). In addition, this model includes AC- PC, this indicating the muscular load, which decrease the blood glucose level, and the AC of the small intestine, where carbohydrates are absorbed into the blood. The right branch of the AC of pancreas has the most significant influence on a fructosamine level with a positive sign (+). The higher index - glycemia level will be higher.

AC	b	SE	t	p
constant	-0.52	0.26	-1.97	0.06
LUr	0.3	0.12	2.39	*0.02
PCl	-0.37	0.16	-2.21	*0.03
SIl	-0.31	0.22	-1.35	0.18
SPr	0.65	0.16	3.92	***0.001

R^2 (Adjusted)=0.35, and the standard error (SE) of the estimate=0.21 for N=28 *p<0.05, **p<0.01, ***p<0.001, + indicates the tendency to significance. The subscripts r and l indicate the right and the left branches of the AC, respectively. AC=acupuncture channel; B=influence coefficient.

Table 5: Regression model linking of the fructosamine with AC in males.

AC	b	SE	t	p
constant	0.34	0.29	1.19	0.23
SIr	0.25	0.13	1.83	0.07
TEl	-0.6	0.28	-2.11	*0.03
KIr	0.27	0.13	2.02	*0.04
HTl	0.55	0.35	1.57	0.12
BLr	-0.04	0.03	-1.24	0.21
VC	0.42	0.12	3.4	***0.001

R^2 (Adjusted)=0.33, and the standard error (SE) of the estimate=0.38 for N=57 *p<0.05, **p<0.01, ***p<0.001, + indicates the tendency to significance. The subscripts r and l indicate the right and the left branches of the AC, respectively. AC=acupuncture channel; B=influence coefficient.

Table 6: Regression model linking of the fructosamine with AC in females.

In Table 6 shows the results of stepwise regression analysis for females. It is marked the same AC that in the regulation of glucose TEl, SIr, KIr, BLr. In addition this model includes channel heart (HTl), which is involved in the regulation of physical activity. Additionally, the Model includes unpaired channel VC with the positive vector of communication which has the most significant effect (p=0.001) on fructosamine level. This channel according to TCM collects all Yang energy which is adequate glucose. The higher the value of VC, then the higher the level of glucose in the blood.

Discussion

Study of temperature sensation is the psychophysiological method. There is no its objective criterion until now, as the temperature pain threshold is subjective. Patient observed, decides himself how to evaluate his sense - either indifferent or the painful, i. e. the method is subjective by its nature.. But the thing is that our mind is essential for all regulatory processes. And if we regard these results as psychological phenomena, we get the tool of evaluation central regulation besides segmental and ganglion level. That said, with TS evaluation we get a new principle, as well as a new instrument for efficient monitoring of carbohydrate metabolism chain. On the other hand, using mathematical analysis as a truth criterion we can see direct implementation of TCM knowledge into results interpretation on the level of concepts of Yang/Yin, right/left symmetry, etc. Thereby using mathematics as an interlink, we are connecting Traditional Chinese Medicine with modern physiology.

There is a significant difference in regulatory correlation of the AC and a glycemia level in groups of males and females patients, that should be considered when performing therapeutic interventions. In females groups a significant disorder in AC liver is observed more often, also there are the significant differences in the triple heater channel (TE), which represents the thyroid status and basal metabolic rate. In male groups there was a dietary factor due to a gastric canal damage along with a tissue hypoxia (AC- LU) and small intestine and pancreas damage, which is more typical for type 1 diabetes. Figure 6 shows a diagram of communication channel SP with the pancreas, described by us previously [16-18]. From this it is clear why the growth SPr with the (+) vector of influence leads to the growth of fructosamine in Table 5. The higher its value TS, the lower the activity of B- cells in the pancreas. In this case the left branch canal of the pancreas reflects the activity of A-cells. Normal indicators of TS have a difference of 10-15%. Inhibition of B-cells at T2D can occur during the periodic injections of insulin, which is applied in part these patients.
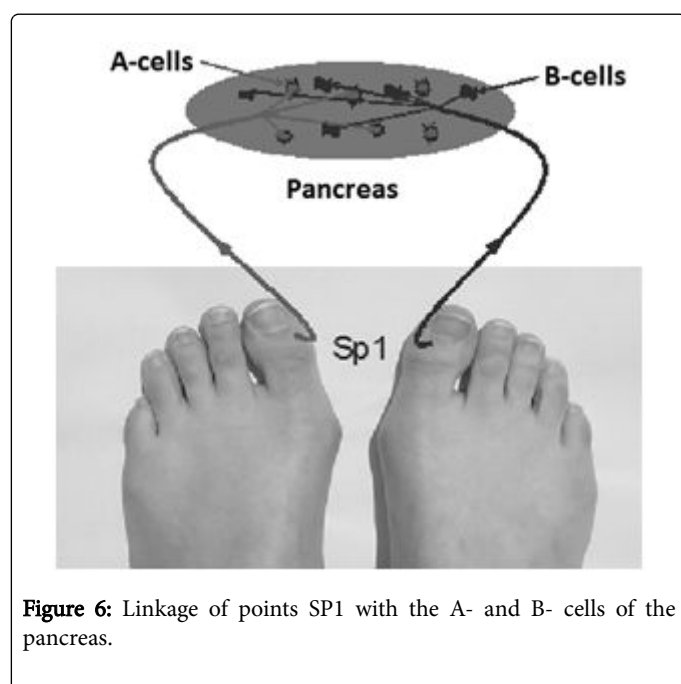

Figure 6: Linkage of points SP1 with the A- and B- cells of the pancreas.

An important difference between male and female patients in profile TS refers to AC- BL, which reflects the status of hormone profile of the reproductive system. Thus, in male patients there is a hypofunction of reproductive hormone systemprobably related with tissue hypoxy in comparison with a norm is observed. In female patients these channels are almost identical to a normal. It is worth mentioning, that recovery of the normal sexual activity in male patients results in a decrease of glycemia.

Besides specific profile of TS those dealing with T2D should pay attention for high TS deviation along various AC in response to changes in glycemic level. It points to presence of compensatory mechanisms maintaining homeostasis of these organs and systems. If as a response to changes in glycemic level TS remain unchanged, it may be indicative of letdown of a body's reserve and compensatory capacities from these systems.

Problem of symmetry/asymmetry in biological objects is fundamental. Unlike inanimate nature, where symmetry predominates, in animate nature everything is asymmetrical, however, normally this asymmetry does not exceed "Golden ratio proportion" of 1.62. Stable higher asymmetry leads to chaos and destruction of an organism [14]. High asymmetry of values in right and left branch of the same AC usually indicates functional or organic pathology in relating organs. Such asymmetry can be effectively removed via reflexotherapy [7,9-11]. Now, influence to CV -12 point results in efficient decrease in glycemia levels at T2D [6-8]. According to our method, stimulating influence shall be performed on the side with high rate of ST, that reflect functional insufficiency. At this, simultaneously with symmetry recovery, main functions of the organ also increase [19,20]. Thus the main goal of such treatment is the restoration of harmony of the energy in the body, which ultimately, according to the TCM creates "healthy body and healthy mind".

The Akabene test enables to obtain an adequate information in digital form on the functional activity of different body systems and organs, which participate in forming of the carbohydrate metabolism chain. Moreover, the patient can perform the test independently by himself within 3-5 minutes only. This approach, unlike the conventional one, which needs a constant estimation of a glycemia level, provides new principles and possibilities especially for telemedicine along with wide acceptance of mathematical analysis. The best way to do it is to construct individual regression models of links between AC and blood sugar level [14,17,19,20]. Moreover, it is possible to construct regression models of how AC is linked to various medicines or their dose or time after administration. In such a manner it is possible to individually find a medicine and its best dose to neutralize sugar level increase acting by the same regression models of links to sugar [14,16]. This method provides new concepts for efficient and applicable monitoring. This is the first attempt to implement this idea was made, creating a conceptional bridge between the eastern and western medicines.

Future directions

In addition, using self-learning neural networks (NGO) on individual databases, it is possible to estimate the blood sugar level with an accuracy sufficient for home monitoring using for the calculations the results of the evaluation TS [21]. Changes in the level of glycemia are always late changes TS because of the buffer properties of the blood. This gives a temporary opportunity to implement a preventive correction to avoid dangerous complications. Even more significant opportunities are opened with the application of the evaluation of individual biorhythms of interested organs and physiological systems. Thus, using Cosinor analysis [22,23] when

processing individual databases, it is possible to predict the level of glycemia for several days ahead with the detection of dangerous time periods. They are formed when, due to interference of different periods of vibration of several sugar-bound channels, a dangerous situation is formed when their total vector from the regression model to the growth and blood sugar increases sharply. In this case, there is more time for targeted correction.

In general, the future development of this technology is associated with the creation of individual devices based on the Akabane test, which have a connection to the server where the data is processed [24].

Disclosure Statement

The authors declare that they have no conflicts of interest and no financial interests related to the material of this manuscript.

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