STUDY ON EFFECT OF STANDARDIZED INSULIN INJECTION TECHNIQUE ON MENTAL STATUS AND BLOOD GLUCOSE IN PATIENTS WITH TYPE 2 DIABETES MELLITUS

YANYAN WANG[1], QIRONG WEI[1], XINYAN XU[2,*]
[1]Department of Endocrinology, Affiliated Hospital of Northwest University for Nationalities, Department of Endocrinology, The second people's Hospital of Gansu Province, Lanzhou, 730030, Gansu, China - [2]Training Center of Affiliated Hospital of Northwest University for nationalities, Training center of the second people's Hospital of Gansu Province, Lanzhou, 730030, Gansu, China

ABSTRACT

Objective*: The purpose was to explore the effect of standardized insulin injection technique on mental status and blood glucose in patients with type 2 diabetes (T2DM).*

Methods: *100 T2DM patients who treated with insulin injection in our hospital from February 2018 to May 2019 were selected as the study subjects, and divided into control group (n=50) and experimental group (n=50) according to their order of admission. Patients of the control group received conventional insulin injection treatment, while those of the experimental group were treated with standardized insulin injection technique to analyze related indexes of mental status and blood glucose in two groups of patients.*

Results: *(1) After treatment, SAS and SDS scores significantly decreased in both groups of patients, and the SAS and SDS scores of the experimental group (50.35±7.28, 46.15±6.21) were significantly lower than those of the control group (56.22±7.05, 50.33±6.03), with statistical significance (T=4.10, 3.41; P<0.001). (2) After treatment, fasting plasma glucose (FPG), 2h postprandial plasma glucose (2h PPG) and glycosylated hemoglobin (HbA1c) significantly decreased in both groups of patients, and the FPG level (8.05±1.22 mmol/L), 2h PPG level (10.32±1.82 mmol/L) and HbA1c level (6.09±0.92%) of the experimental group were significantly lower than (9.15±1.33) mmol/L, (12.02±1.90) mmol/L and (7.12±0.95)% of the control group, with statistical significance (T=4.31, 4.57, 5.51; P<0.001). (3) The occurrence of adverse events such as subcutaneous lipomatosis, needle reuse and hypoglycemia in the experimental group was significantly lower than that in the control group, with statistical significance (T/X2=16.00, 6.32, 12.25; P<0.001).*

Conclusion: *Standardized insulin injection technique for T2DM patients can improve their adverse mental status and have a positive effect on the long-term stability of blood glucose control.*

Keywords: *Standardization, insulin injection technique, type 2 diabetes mellitus (T2DM), mental status, effect on blood glucose.*

DOI: 10.19193/0393-6384_2021_4_380

Received *October 15, 2020;* ***Accepted*** *March 20, 2021*

Introduction

In recent years, with the continuous improvement of people's living standards, the incidence of diabetes mellitus (DM) has been increasing year by year, which has now become one of the major diseases threatening health of people all over the world[1-3]. Insufficient insulin secretion is the main cause of DM, which is characterized by blood glucose increase in clinic. According to relevant reports, most T2DM patients need insulin treatment as their condition progresses[4]. Insulin treatment refers to the control of blood glucose by subcutaneous injection of insulin 3-4 times a day on the basis of exercise and dietary control. Insulin injection sites include the lateral thigh, abdomen (outside part of 5cm around the umbilicus), upper outer quadrant of the buttock, lower edge of the upper arm deltoid, etc, avoiding blood vessels, nerves and joints[5-7]. However, the rate of insulin absorption varies in each part. Generally, the rate from slow to fast is buttock, thigh, arm and abdomen,

and the onset time of insulin injection is different in different parts. Nowadays, insulin injection is not standardized in clinical practice, which affects the effect of blood glucose control.

Therefore, standardized insulin injection is the premise of improving blood glucose level[8]. This study is aimed to explore the effect of standardized insulin injection technique on the mental status and blood glucose in T2DM patients, providing an important reference for blood glucose control of T2DM patients, specifically reported as follows.

Materials and methods

General information

100 T2DM patients who treated with insulin injection in our hospital from February 2018 to May 2019 were selected as the study subjects, and divided into control group and experimental group according to their order of admission. The control group had 23 males and 27 females with a total of 50 cases, aged 26-86 years old with an average age of (47.22±6.08) years old and an average weight of (68.88±9.84) kg. The experimental group had 24 males and 26 females with a total of 50 cases, aged 27-85 years old with an average age of (47.32±6.03) years old and an average weight of (68.79±9.88) kg. There was no significant difference in general clinical data such as age and weight between the two groups of patients (P>0.05), which was comparable.

Inclusion/exclusion criteria

Inclusion criteria:

• All subjects met diagnostic criteria of World Health Organization (WHO) for T2DM, and their FPG level was equal to or more than 7.0 mmol/L and 2h PPG level was equal to or more than 11.1 mmol/L;

• The patients did not take hypoglycemic drugs;

• This study was approved by the hospital ethics committee, and the patients and their families knew the treatment and signed a consent form.

Exclusion criteria:

• The patient had neurological and language disorders;

• The patients had acute diabetic nephropathy, liver and other complications;

• The patients had type 1 diabetes or gestational diabetes.

Methods

After admission, patients in both groups received individualized diet and exercise plans formulated by medical staff, and health education was implemented by means of brochures and videos. A glucometer (Roche) was used to adjust the insulin dosage of patients and control the blood glucose level to the normal range. Patients in the control group were treated with conventional insulin injection while those in the experimental group were treated with standardized insulin injection technique with specific methods as follows.

Needle use

Patients were reminded to change needle in each injection to avoid reuse.

Injection sites

Abdomen was short-acting insulin injection site before meals and thigh was site before bedtime. Each site was meshed, and the size of each injection area was 2.0 cm x 2.0 cm. The site was changed to the opposite side after injection of one site.

Injection method

Before injection, the skin of the injection area was disinfected and the needle was injected vertically. The needle was inserted or pulled out quickly, and the drug was injected slowly with stay of the needle for 5-10 seconds after injection.

After discharge

The patients were followed up by telephone every week after discharge to answer their questions and advise them to inject insulin in a standardized way.

Insulin in both groups was purchased from Jiangsu Wanbang Biochemical Medicine with SFDA approval number No. H10890001. All the needles were ultra-short and ultra-fine needles of 31Gx5mm from BD Company.

Evaluation indexes

Before and after treatment, SAS (Self-rating Anxiety Scale) and SDS (Self-rating Depression Scale) were used to evaluate the degree of anxiety and depression in both groups of patients. The higher the SAS and SDS scores were, the more serious the bad mental status such as anxiety and depression in patients was. After 1 year of treatment, HbAlc (glycosylated hemoglobin), FPG (fasting plasma glucose) and 2h PPG (postprandial plasma glucose) were detected and compared between the two groups of patients. The occurrence of subcutaneous lipomatosis, needle reuse, hypoglycemia and other adverse events within 1 year in the two groups were analyzed.

Statistical processing

The data in this study were statistically processed and analyzed by data software SPSS20.0. The measurement data were measured by t test, expressed by ($\bar{x}\pm s$), and the count data was tested by X^2, expressed by [n(%)]. The difference was statistically significant when $p<0.05$.

Results

Analysis of mental status in two groups of patients

Before treatment, there was no significant difference in SAS and SDS scores between the experimental group (62.89±9.05, 61.35±9.27) and the control group (62.58±9.01, 61.15±9.66, T=0.17, 0.11; P=0.86, 0.92). After treatment, SAS and SDS scores significantly decreased in both groups of patients, and the SAS and SDS scores of the experimental group (50.35±7.28, 46.15±6.21) were significantly lower than those of the control group (56.22±7.05, 50.33±6.03), with statistical significance (T=4.10, 3.41; P<0.001), as shown in Figures 1-2.

Analysis of FPG level in two groups of patients

Before treatment, there was no significant difference in FPG level between the experimental group (10.42±2.16 mmol/L) and the control group (10.38±2.08 mmol/L, T=0.09, P=0.93).

After treatment, the FPG level of both groups significantly decreased, and the FPG level of the experimental group (8.05±1.22) mmol/L was significantly lower than that of the control group (9.15±1.33) mmol/L, with statistical significance (T=4.31, P<0.001), as shown in Figure 3.

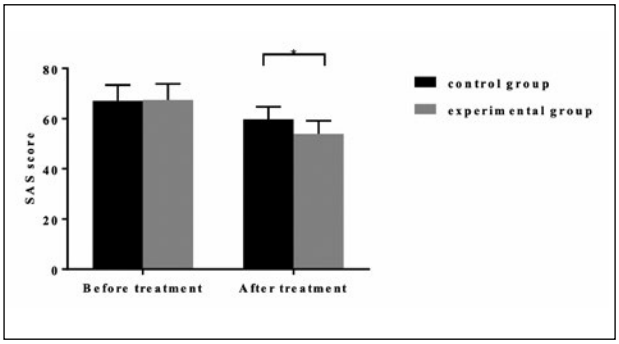

Figure 1: Comparison of SAS scores between the two groups.

*Note: The abscissa from left to right represents before treatment and after treatment respectively, and the ordinate represents SAS score (unit: point). As shown in Figure 1, the SAS score of the experimental group after treatment was significantly lower than that of the control group. *indicates that P<0.001 was statistically significant.*

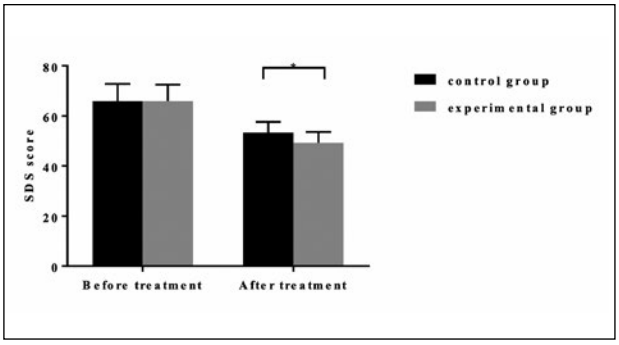

Figure 2: Comparison of SDS scores between the two groups.

*Note: The abscissa from left to right represents before treatment and after treatment respectively, and the ordinate represents SDS score (unit: point). As shown in Figure 2, the SDS score of the experimental group after treatment was significantly lower than that of the control group. *indicates that P<0.001 was statistically significant.*

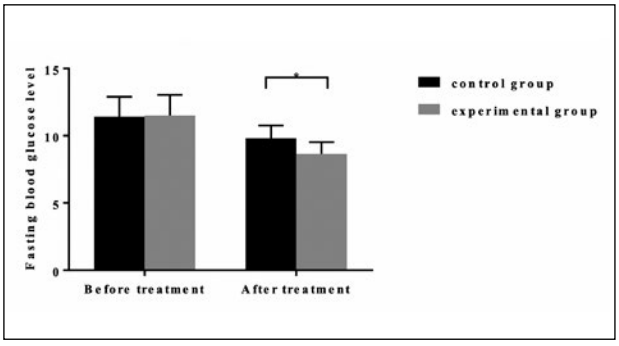

Figure 3: Comparison of FPG level between the two groups.

*Note: The abscissa from left to right represents before treatment and after treatment respectively, and the ordinate represents FPG level (unit: mmol/L). As shown in Figure 3, the FPG level of the experimental group after treatment was significantly lower than that of the control group. *indicates that P<0.001 was statistically significant.*

Analysis of 2h PPG level in two groups of patients

Before treatment, there was no significant difference in 2h PPG level between the experimental group (14.37±2.97 mmol/L) and the control group (14.26±2.71 mmol/L, T=0.19, P=0.85).

After treatment, the 2h PPG level in the two groups of patients significantly decreased, and level of the experimental group (10.32±1.82 mmol/L) was significantly lower than that of the control group (12.02±1.90 mmol/L), with statistical significance (T=4.57, P<0.001), as shown in Figure 4.

Analysis of HbA1c in two groups of patients

Before treatment, there was no significant difference in HbA1c between the experimental group (8.98±1.04%) and the control group (8.83±1.07%, T=0.71, P=0.48). After treatment, the HbA1c of both

groups significantly decreased, and the HbA1c of the experimental group (6.09±0.92%) was significantly lower than that of the control group (7.12±0.95%), with statistical significance (T=5.51, P<0.001), as shown in Figure 5.

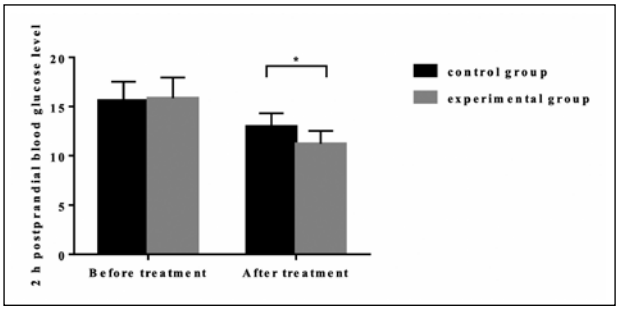

Figure 4: Comparison of 2h PPG level in two groups.
*Note: The abscissa from left to right represents before treatment and after treatment respectively, and the ordinate represents 2h PPG level (unit: mmol/L). As shown in Figure 4, the 2h PPG level of the experimental group after treatment was significantly lower than that of the control group. *indicates that P<0.001 was statistically significant.*

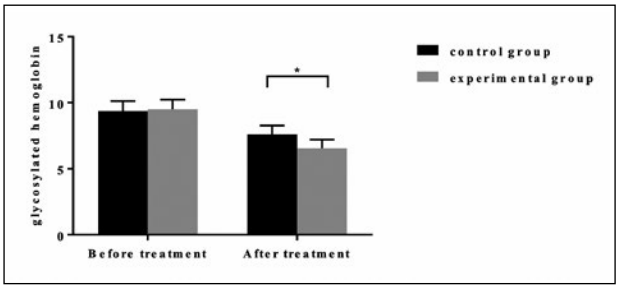

Figure 5: Comparison of HbA1c between the two groups.
*Note: The abscissa from left to right represents before treatment and after treatment respectively, and the ordinate represents HbA1c (unit: %). As shown in Figure 5, the HbA1c of the experimental group after treatment was significantly lower than that of the control group. *indicates that P<0.001 was statistically significant.*

Analysis of adverse events of insulin injection in two groups of patients

The occurrence of adverse events such as subcutaneous lipomatosis, needle reuse and hypoglycemia in the experimental group was significantly lower than that in the control group, with statistical significance (T/X^2=16.00, 6.32, 12.25; P<0.001), as shown in Table 1.

Group	Number of cases	Subcutaneous lipomatosis (%)	Needle reuse (times)	Hypoglycemia (%)
Control group	50	36% (18/50)	7.23±3.55	34% (17/50)
Experimental group	50	4% (2/50)	3.88±1.21	6%(3/50)
T/X^2		16.00	6.32	12.25
P		0.00	0.00	0.00

Table 1: Incidence of adverse events of insulin injection in two groups of patients.

Discussion

Diabetes mellitus (DM) is one of the common chronic diseases in clinic[9]. In recent years, with the continuous improvement of people's living standards and the dramatic changes in dietary structure, the DM incidence in China is increasing year by year[10-12]. According to relevant clinical studies, type 1 DM patients need lifelong insulin treatment, and many T2DM patients receive insulin treatment for the complications occurring with the continuous development of the disease. Relevant investigations show that 61.55% of T2DM patients in China are treated with insulin. Insulin is an important means to control blood glucose level in T2DM patients, and insulin injection technique is one of the main factors affecting the efficacy of insulin treatment[13-15]. Whether insulin can be injected correctly affects the efficacy of insulin treatment and treatment degree of T2DM patients. Therefore, health education should be carried out for T2DM patients through various forms so that they can be injected with insulin in a standardized way, which has a positive effect on improving treatment compliance and controlling blood glucose level of T2DM patients.

According to the study of Kazemian Pooyan[16] et al, about 30% of T2DM patients never rotate the injection sites with the needle reuse rate as high as 85%. With the increasing injection time of T2DM, the needle reuse rate also increases, leading to the continuous increase of subcutaneous lipomatosis in patients. Needle reuse is the the main factor for occurrence of subcutaneous lipomatosis at the injection sites, which can lead to unexplained hypoglycemia in patients, not conductive to blood glucose control[17-19]. The majority of T2DM patients are the elderly, and its treatment is a long process. In addition, patients need frequent injection, which can easily cause non-standardized injection such as incomplete disinfection, etc. Meanwhile, patients are also prone to adverse mental status such as anxiety and depression, seriously affecting the clinical effect of insulin treatment[20-23]. Implementation of training about standardized insulin injection technique and telephone follow-up can improve the adverse mental status of the patients, enhance their self-management ability and standardize insulin injection.

This study was aimed to explore the effect of standardized insulin injection technique on mental status and blood glucose in T2DM patients, and the results showed that the mental status of patients in the experimental group after standardized insulin

injection treatment was significantly better than that in the control group, and the occurrence of adverse events such as subcutaneous lipomatosis, needle reuse and hypoglycemia in the experimental group decreased significantly. This indicates that standardized insulin injection treatment for T2DM patients can improve adverse mental status and reduce the occurrence of adverse events.

Medical staff should fully communicate with T2DM patients in various aspects during insulin treatment, and then emphasize the combination of medical care and self-management[24-25]. According to the specific conditions of patients, medical staff should not only maintain the blood glucose level of patients during hospitalization, but also strengthen the training of standardized insulin injection technique and follow-up for patients before or after discharge. The results of this study showed that the control effect of HbA1c, FPG and 2h PPG levels in the experimental group was significantly better than that in the control group, with statistical significance ($P<0.001$), indicating that the non-standardized insulin injection in T2DM patients is one of the reasons for the poor blood glucose control.

In conclusion, standardized insulin injection technique for T2DM patients can improve their adverse mental status and have a positive effect on the long-term stability of blood glucose control.

References

1) Regue, Laura, Widrick, Jeffrey J., Minichiello, Liliana, et al. IMP2 Increases Mouse Skeletal Muscle Mass and Voluntary Activity by Enhancing Autocrine Insulin-Like Growth Factor 2 Production and Optimizing Muscle Metabolism[J]. Molecular and Cellular Biology, 2019, 39(7).
2) Weili Xue, Jin Huang, Hong Chen, et al. Histone methyltransferase G9a modulates hepatic insulin signaling via regulating HMGA1[J]. Biochimica et biophysica acta. Molecular basis of disease: BBA, 2018, 1864(2): 338-346.
3) Boland, Brandon B., Brown, Charles, Jr., Alarcon, Cristina, et al. beta-Cell Control of Insulin Production During Starvation-Refeeding in Male Rats[J]. Endocrinology, 2018, 159(2): 895-906.
4) Della Corte, T., Strollo, F., Gentile, S., et al. Skin complications of insulin injections: A case presentation and a possible explanation of hypoglycaemia[J]. Diabetes research and clinical practice, 2018, 138: 284-287.
5) Luigi E Adinolfi, Riccardo Nevola, Barbara Guerrera, et al. Hepatitis C virus clearance by direct-acting antiviral treatments and impact on insulin resistance in chronic hepatitis C patients[J]. Journal of Gastroenterology and Hepatology, 2018, 33(7): 1379-1382.
6) Arun. Pande, Ajay. Aggarwal, Roopak. Wadhwa. Reduced efficacy of insulin detemir in controlling hyperglycemia during pregnancy: An interesting case report[J]. Indian Journal of Endocrinology and Metabolism, 2018, 22(2): 292-295.
7) Jean-Claude Henquin. Influence of organ donor attributes and preparation characteristics on the dynamics of insulin secretion in isolated human islets[J]. Physiological Reports, 2018, 6(5): n/a-n/a.
8) Heidenberg, Daniel J., Haney, Nora M., Rezk, Bashir M., et al. Pioglitazone's beneficial effects on erectile function preservation after cavernosal nerve injury in the rat are negated by inhibition of the insulin-like growth factor-1 receptor: a preclinical study[J]. International journal of impotence research, 2019, 31(1): 1-8.
9) Charles Cai, Kay D. Beharry, Taimur Ahmad, et al. Intermittent hypoxia suppression of growth hormone and insulin-like growth factor-I in the neonatal rat liver[J]. Growth hormone and IGF research: Official journal of the Growth Hormone Research Society and the International IGF Research Society, 2018, 41: 54-63.
10) Chung, Stephen Sum Man, Jayachandran, Muthukumaran, Xu, Baojun, et al. Isoquercetin ameliorates hyperglycemia and regulates key enzymes of glucose metabolism via insulin signaling pathway in streptozotocin-induced diabetic rats[J]. European Journal of Pharmacology: An International Journal, 2018, 829: 112-120.
11) Rinaldi Luca, Giordano Mauro, Adinolfi Luigi E, et al. Hepatitis C virus clearance by direct-acting antiviral treatments and impact on insulin resistance in chronic hepatitis C patients[J]. Journal of gastroenterology and hepatology, 2018, 33(7): 1379-1382.
12) Lehmann, Reiner, Liu, Lijiang, Giacca, Adria, et al. Combined Hyperglycemia - and Hyperinsulinemia-Induced Insulin Resistance in Adipocytes Is Associated With Dual Signaling Defects Mediated by PKC-zeta[J]. Endocrinology, 2018, 159(4): 1658-1677.
13) Amany. Mohammed, Faiza. AbdelRehem, Olfat. Hendy, et al. The role of adiponectin, insulin resistance, and vitamin D as predictors of transformation of fatty liver to hepatocellular carcinoma[J]. The Scientific Journal of Al-Azhar Medical Faculty, Girls, 2018, 2(1): 20-25.
14) Ibias, Javier, Nazarian, Arbi, O'Dell, Laura E. Insulin dependent and independent normalization of blood glucose levels reduces the enhanced rewarding effects of nicotine in a rodent model of diabetes[J].Behavioural Brain Research: An International Journal, 2018, 351: 75-82.
15) Chan, Catherine B., Jacobs, Rene L.,Wang, Xiaofeng, et al. Both low- and regular-fat cheeses mediate improved insulin sensitivity and modulate serum phospholipid profiles in insulin-resistant rats[J]. The Journal of Nutritional Biochemistry, 2019, 64: 144-151.
16) Kazemian Pooyan, Wexler Deborah J, Fields Naomi F et al. Development and Validation of PREDICT-DM: A New Microsimulation Model to Project and Evaluate Complications and Treatments of Type 2 Diabetes Mellitus[J]. Diabetes Technol. Ther., 2019, 21: 344-355.

17) Derkach, K. V., Perminova, A. A., Buzanakov, D. M., et al. Intranasal Administration of Proinsulin C-Peptide Enhances the Stimulating Effect of Insulin on Insulin System Activity in the Hypothalamus of Diabetic Rats[J]. Bulletin of experimental biology and medicine, 2019, 167(3): 351-355.
18) Smith, Jessica, Galloway, Stacey, Wheatcroft, Stephen B., et al. Endothelial Insulin Receptor Restoration Rescues Vascular Function in Male Insulin Receptor Haploinsufficient Mice[J].Endocrinology, 2018, 159(8): 2917-2925.
19) Cruz-Cazarim, Estael L. C., Cazarim, Maurilio S., Ogunjimi, Abayomi T., et al. Prospective insulin-based ophthalmic delivery systems for the treatment of dry eye syndrome and corneal injuries[J]. European journal of pharmaceutics and biopharmaceutics: official journal of Arbeitsgemeinschaft fuer Pharmazeutische Verfahrenstechnik e.V, 2019, 140:1-10.
20) Leslie A. Consitt, Gunjan Saxena, Yuriy Slyvka, et al. Paternal high-fat diet enhances offspring whole-body insulin sensitivity and skeletal muscle insulin signaling early in life[J]. Physiological Reports, 2018, 6(5): n/a-n/a.
21) Corbit, Kevin C., Camporez, Joao Paulo G., Edmunds, Lia R., et al. Adipocyte JAK2 Regulates Hepatic Insulin Sensitivity Independently of Body Composition, Liver Lipid Content, and Hepatic Insulin Signaling[J]. Diabetes: A Journal of the American Diabetes Association, 2018, 67(2): 208-221.
22) Fine, Nicholas H. F., Doig, Craig L.,Elhassan, Yasir S., et al. Glucocorticoids Reprogram beta-Cell Signaling to Preserve Insulin Secretion[J]. Diabetes: A Journal of the American Diabetes Association, 2018, 67(2): 278-290.
23) Yamamoto, Masaki, Guo, De-Huang, Hernandez, Caterina M., et al. Endothelial Adora2a Activation Promotes Blood-Brain Barrier Breakdown and Cognitive Impairment in Mice with Diet-Induced Insulin Resistance[J]. The Journal of Neuroscience: The Official Journal of the Society for Neuroscience, 2019, 39(21): 4179-4192.
24) Jiqu Xu, Hui Gao, Li Zhang, et al. Melatonin alleviates cognition impairment by antagonizing brain insulin resistance in aged rats fed a high-fat diet[J]. Journal of Pineal Research, 2019, 67(2): n/a-n/a.
25) Steely Andrea M, Smith Lisa, Callas Peter W et al. Prospective Study of Postoperative Glycemic Control with a Standardized Insulin Infusion Protocol after Infrainguinal Bypass and Open Abdominal Aortic Aneurysm Repair.[J]. Ann Vasc Surg, 2017, 44: 211-220.

Acknowledgement
Funding: Supported by the Fundamental Research Funds for the Central Universities. 31920190193.

Corresponding Author:
Xinyan Xu
Training Center of Affiliated Hospital of Northwest University for nationalities, Training center of the second people's Hospital of Gansu Province,No.1 Hezheng West Street, Chengguan District, Lanzhou, 730030, Gansu, China
Email: 271663008@qq.com
(China)