CLINICAL AND ELECTROPHYSIOLOGICAL FEATURES OF PATIENTS WITH IMPAIRED GLUCOSE TOLERANCE AND PERIPHERAL NEUROPATHY IN HAN, HUI AND XIBE NATIONALITIES

Jia Huo[1*], Xiu-Ju Huang[1], Bahetiguli Yesimuhan1[1], Li-Sha Guo[1], Ye Er Jiang[1], Yu-Qing Liu[1], Chun ling Lin[1], Re He Man[1], Yang Zhang[2], Zheng-Xian Tao[3]

[1]Department of neurology, Xinjiang Yili Friendship Hospital, Xin Jiang, 835000, China - [2]Department of endocrinology, Xinjiang Yili Friendship Hospital , Xin Jiang, 835000, China - [3]Department of Internal Cardiovascular, Jiangsu Province People's Hospital, Nanjing 210000, China

ABSTRACT

Objective: *This study was designed to primarily investigate the clinical and electrophysiological features of impaired glucose tolerance (IGT) patients with peripheral neuropathy (PN) in Han, Hui and Xibe nationalities.*

Methods*: A total of 300 IGP patients with PN who were treated in the Department of Neurology, Yili Friendship Hospital of Xinjiang Autonomous Region from January 2013 to June 2016 were enrolled into the present study (n=100, each for Han, Hui and Xibe patients).*

Results*: (1) The proportion of patients with pressure hypesthesia and pallhypesthesia was significantly higher in Xibe nationality patients than in Han and Hui nationality patient, and the differences were statistically significant (P=0.008, P=0.000). (2 Results of the motor nerve conduction in the three groups: the proportion of abnormal amplitude of the lower limbs was significantly higher than that of the upper limbs, and the proportion of abnormal amplitude of the common peroneal nerve was the highest (22%, 26%, 33%, respectively). The proportion of abnormal amplitude of the ulnar nerve amplitude in Xibe nationality patients was compared with that of Han and Hui nationality patients (P=0.002), and the reduction of amplitude of the ulnar nerve and common peroneal nerve was higher in Xibe nationality patients than in Han and Hui nationality patients (P=0.000 and P=0.027). (3) In all three groups, the rate of abnormal amplitude of the sensory nerve was higher than that of the motor nerve: Han, 29.5% (118/400) vs. 14% (56/400), P=0.000; Hui: 28.3% (113/400) vs. 13.8% (55/400), P=0.000; Xibe: 35.8% (143/400) vs. 21.5% (86/400), P=0.000.*

Conclusions*: The clinical and electrophysiological features of Han, Hui and Xibe nationality patients with IGT and PN mainly manifest as sensory nerve damages, and these clinical and electrophysiological manifestations are more severe in Xibe nationality patients.*

Keywords: *impaired glucose tolerance, peripheral neuropathy, Neural conduction, racial differences.*

DOI: 10.19193/0393-6384_2019_6_494

Received *November 30, 2018;* ***Accepted*** *February 20, 2019*

Introduction

Diabetes is a worldwide public health concern that presently affects more than 382 million people globally. By 2025, this figure is expected to rise to 592 million[(1)]. PN is one of the most common complications of type-2 diabetes, and it can affect the incidence and mortality of type-2 diabetes[(2,3)]. IGT refers to the intermediate state between normal blood sugar level and the blood sugar level of diabetic patients.

Approximately 148 million 200 thousand people are at high risk of diabetes in China, and this population is the impaired glucose tolerance (IGT) population. This population is a high risk group of diabetic peripheral neuropathy (PN)[(4)]. IGT aggravates peripheral nerve damage, and its incidence is higher than that in the normal population. If IGT population can be intervened in the early stages, the progression from IGT into diabetes mellitus can be delayed, and peripheral nerve damage can be reduced[(5)]. Some scholars have considered that PN induced by IGT is characterized by subclinical small nerve fiber lesion and autonomic neuropathy[(6,7)].

A study has demonstrated that IGT has become an independent risk factor for PN[(8)]. Furthermore, nerve conduction studies (NCS) have been considered as the gold standard for determining the damage of PN[(9)], and has been applied in studies on PN in type-1 and type-2 diabetes mellitus. NCS have high sensitivity to the segmental demyelination of gan-

glia, and can dynamically reflect the degree of nerve damage. In IGT patients, a great amount of nerve fibers are damaged in early stage[10]. Hence, NCS is also important for IGT patients. Some scholars have proposed that peripheral nerve impairment induced by IGT was involved in damages induced to a large amount of nerve fibers[11], while other studies have demonstrated the degree of damage to the peripheral nerve in diabetes through NCS, in which damages to both large and small nerve fibers were found[12].

Recent studies have demonstrated that IGT can also lead to PN, and the corresponding incidence was significantly higher than that in the normal population[13]. Furthermore, some prospective studies that focused on "idiopathic neuropathy" have found that 30-50% of patients have IGT[14]. Hence, the early detection and diagnosis of PN induced by IGT are of great significance.

The Xinjiang Uygur Autonomous Region is a multi-ethnic residential area, and studies carried out in this region have revealed that there are differences in endocrine and metabolic diseases among different ethnic groups. In the present study, the differences in the clinical and electrophysiological features of IGT patients with PN among Han, Hui and Xibe nationalities were analyzed.

Materials and methods

Clinical data

A total of 300 IGP patients with PN who were initially diagnosed and treated in the Department of Neurology, Yili Friendship Hospital of Xinjiang Autonomous Region from January 2013 to June 2016 were enrolled into the present study (n=100, for each Han, Hui and Xibe nationatily). All patients included in the present study met the definition of IGT developed by the Diabetes Expert Committee of the World Health Organization (WHO) and the International Diabetes Federation (IDF) in 1999: fasting blood glucose of <7 mmol/L (126 mg/dl), and 2-hour postprandial blood glucose of >7.8 mmol/ L (140 mg/dl), but <11.1 mmol/ L (200 mg/dl). Patients with the following lesions or factors were not included into the cohort: cervical and lumbar diseases (nerve root compression, spinal stenosis, and cervical and lumbar degeneration), cerebral infarction, Guillain-Barre syndrome, severe arteriovenous vascular lesions (venous embolism and lymphangitis), renal dysfunction, and neurotoxicity caused by chemotherapeutic drugs and metabolic toxicants. In the present study, 300 patients who meet the above-mentioned criteria were included. Among these patients, 100 patients were Han, 100 patients were Hui and 100 patients were Xibe. Furthermore, among these 300 patients, 105 patients (35%) were male, and the age of patients who underwent the electrophysiological examination ranged within 29-84 years old (53.1 ± 9.02 years old). Age, height, weight, waistline, baseline fasting blood glucose, 2-hour postprandial blood glucose, glycated hemoglobin, blood lipids, clinical primary symptom of the nervous system, electrophysiological parameters and other indexes were included into the analysis.

Electrophysiological examination

A Keypoint electromyograph and supporting products was used (Dantec, Denmark). The examinee was allowed to stay in a relaxed state and lay in a quiet environment, the room temperature was >20°C, and skin temperature was maintained at 35°C or above. Motor nerve conduction examination was performed to examine the right median nerve, ulnar nerve and common peroneal nerve. Then, sensory nerve conduction examination of the upper and lower limbs was performed to examine the right median nerve, ulnar nerve, and superficial peroneal and sural sensory nerve. The analysis indexes included the incubation period, wave amplitude and conduction velocity. The normal value ranges were based on the reference values for different ages in the "Clinical Electrophysiology of the Nervous System" written by Xiaofu Tang in China. The diagnostic criteria of abnormalities included the prolongation of the terminal incubation period, decreased conduction velocity, or a mean reduction of amplitude by ±2.5 seconds. In addition, the conclusions reported by correlated foreign studies were taken into account in the comprehensive analysis[15].

Statistical analysis

Data were analyzed using statistical software SPSS 17.0. Normally distributed measurement data were expressed as mean ± standard deviation (x ± SD), and intergroup comparison was conducted using univariate analysis of variance. Count data were expressed as rate, and intergroup comparison was conducted using X2-test. $P<0.05$ was considered statistically significant.

Results

Among the patients included in the present study, the mean waistline was significantly higher in

Han nationality patients than in Hui and Xibe nationality patients (P=0.000), and the difference between Hui and Xibe nationality patients was not statistically significant. Furthermore, the differences in age, BMI, blood sugar and blood lipid levels among the three groups were not statistically significant. The proportion of patients with pressure hypesthesia and pallhypesthesia was significantly higher in Xibe nationality patients than in Han and Hui nationality patients (P=0.008, P=0.000). The main clinical symptoms were numbness of the limbs in all three groups, and the difference was not statistically significant. The specific results are present in Table 1.

	Han(n=100)	Hui(n=100)	Xibe(n=100)	P value
Age (year)	52.06±9.72	53.21±10.39	53.98±10.20	0.402
Male (case,%)	38(38)	34(34)	33(33)	0.682
Waist (cm)	101.08±13.67	92.83±11.10	94.88±13.12	0.000*
BMI (kg/m^2)	26.03±5.59	26.38±3.34	25.95±3.86	0.762
Empty stomach GLU (mmol/l)	5.83±0.67	5.87±0.66	5.91±0.72	0.362
HbA1C (%)	5.82±0.17	5.92±0.39	5.86±0.42	0.322
2hGLU (mmol/l)	8.42±1.72	8.14±1.47	8.24±1.52	0.355
TCHO (mmol/l)	4.60±1.37	4.26±0.98	4.39±0.94	0.104
TG (mmol/l)	2.03±1.32	2.16±1.38	2.11±0.98	0.236
HDL-C (mmol/l)	1.48±1.36	1.38±0.64	1.33±0.43	0.494
LDL-C (mmol/l)	2.32±0.98	2.17±0.92	2.13±0.85	0.307
pressure hypesthesia (case,%)	30(30)	24(24)	44(44)	0.008*
pallhypesthesia (case,%)	21(21)	8(8)	31(31)	0.000*
Clinical manifestation				0.087
Numbness of limbs(case,%)	42	56	44	-
Spontaneous pain (case,%)	2	3	2	-
Othor (case,%)	1	6	6	-
Asymptomatic (case,%)	55	35	48	-

Table 1: Differences in baseline data and clinical symptoms among the Han, Hui and Xibe nationalities.
*Note: *P<0.05 with statistical significance.*

Comparison of electrophysiological examination results of the motor nerve among Han, Hui and Xibe nationalities

The results of motor nerve conduction in the three groups revealed that the following: The damage was severer in the lower extremities than in the upper extremities: the proportion of lower limbs with abnormal amplitude was significantly higher than that of the proportion of upper limbs, and the proportion of abnormal amplitude of common peroneal nerves was the highest (22%, 26% and 33%, respectively). Among these three groups, the proportion of patients with abnormal amplitude of the ulnar nerve was significantly higher in Xibe nationality patients, compared with Han and Hui nationality patients (P=0.002), while the amplitude reduction of the ulnar nerve and common peroneal nerve was higher in Xibe nationality patients, compared with Han and Hui nationality patients (P=0.000 and P=0.027), and the differences were all statistically significant. The differences in the proportion of patients with abnormal motor conduction velocity, the mean value of motor conduction velocity, the proportion of patients with abnormal distal motor incubation period, and the mean value of the distal motor incubation period among the three groups were not statistically significant. The specific results are presented in Table 2.

	Han (n=100)	Hui (n=100)	Xibe (n=100)	P value
Ulnar nerve				
Amplitude, anomaly [case(%)]	10 (10)	11 (11)	33 (33)	0.682
Amplitude (mv), ($\bar{x}$±s)	7.92±1.92	8.58±2.06*	94.88±13.12	0.000*
DML, anomaly [case(%)]	9(9)	7(7)	25.95±3.86	0.762
DML (ms), ($\bar{x}$±s)	2.56±0.35	2.62±0.39	5.91±0.72	0.362
Velocity, anomaly [case (%)]	8(8)	6(6)	5.86±0.42	0.322
Velocity (m/s), ($\bar{x}$±s)	57.09±5.52	57.31±5.58	8.24±1.52	0.355
Median nerve				
Amplitude, anomaly [case(%)]	7(7)	5(5)	11(11)	0.103
Amplitude(mv), ($\bar{x}$±s)	8.99±2.48	9.21±2.46	8.58±2.46	0.178
DML, anomaly [case(%)]	13(13)	12(12)	15(15)	0.817
DML(ms), ($\bar{x}$±s)	3.45±0.59	3.56±0.61	3.60±0.79	0.200
Velocity, anomaly [case(%)]	11(11)	9(9)	12(12)	0.783
Velocity(m/s), ($\bar{x}$±s)	55.53±6.42	55.95±6.04	55.22±4.89	0.667
Tibial nerve				
Amplitude, anomaly[case(%)]	23(23)	17(17)	27(27)	0.232
Amplitude (mv), ($\bar{x}$±s)	6.99±3.83	7.57±5.31	7.01±3.68	0.559
DML, anomaly [case(%)]	11(11)	11(11)	14(14)	0.753
DML(ms), ($\bar{x}$±s)	3.74±0.83	3.64±0.85	3.62±0.68	0.219
Velocity, anomaly [case(%)]	13(13)	12(12)	16(16)	0.693
Velocity(m/s), ($\bar{x}$±s)	49.01±7.05	48.84±5.21	48.58±6.00	0.109
Common Peroneal Nerve				
Amplitude, anomaly [case(%)]	22(22)	26(26)	33(33)	0.207
Amplitude(mv), ($\bar{x}$±s)	0.83±0.86	0.67±0.54	0.59±0.48*	0.027
DML, anomaly [case(%)]	16(22)	18(18)	21(21)	0.722
DML(ms), ($\bar{x}$±s)	5.15±2.86	4.66±0.84	4.68±0.79	0.245
Velocity, anomaly [case(%)]	7(7)	6(6)	9(9)	0.709
Velocity(m/s), ($\bar{x}$±s)	56.83±12.01	55.79±11.66	57.84±12.56	0.212

Table 2: Comparison of electrophysiological examination results of the motor nerve among Han, Hui and Xibe nationalities.
*Note: *, compared with Han, there were significant differences; #, comparing with Hui, there was significant differences.*

Comparison of electrophysiological examination results of the sensory nerve among Han, Hui and Xibe nationalities

In the three groups the abnormal rate of wave amplitude of sensory nerve damage was heavier, compared to that of the motor nerve: Han, 29.5% (118/400) vs. 14% (56/400), P=0.000; Hui: 28.3% (113/400) vs. 13.8% (55/400), P=0.000; Xibe: 35.8% (143/400) vs. 21.5% (86/400), P =0.000.

	Han(n=100)	Hui(n=100)	Xibe(n=100)	P value
Ulnar nerve				
Amplitude, anomaly [case (%)]	21(21)	20(20)	27(27)	0.441
Amplitude (mv), ($\bar{x}$±s)	16.81±10.67	14.60±10.73	17.63±14.36	0.186
DML, anomaly [case (%)]	8(8)	5(5)	9(9)	0.529
DML(ms), ($\bar{x}$±s)	2.09±0.38	2.05±0.24	2.11±0.33	0.426
Velocity, anomaly [case (%)]	14(14)	13(13)	16(16)	0.827
Velocity(m/s), ($\bar{x}$±s)	52.12±6.54	52.72±5.88	52.24±7.72	0.804
Median nerve				
Amplitude, anomaly [case(%)]	23(23)	20(20)	27(27)	0.596
Amplitude (mv), ($\bar{x}$±s)	18.98±12.65	18.18±14.06	20.81±16.26	0.423
DML, anomaly [case (%)]	5(5)	7(7)	8(8)	0.687
DML(ms), ($\bar{x}$±s)	2.11±0.28	2.12±0.32	2.16±0.33	0.507
Velocity, anomaly [case(%)]	15(15)	13(13)	17(17)	0.731
Velocity(m/s), ($\bar{x}$±s)	50.56±7.99	51.28±7.76	51.95±7.89	0.457
Tibial nerve				
Amplitude, anomaly [case(%)]	33(33)	32(32)	39(39)	0.531
Amplitude(mv), ($\bar{x}$±s)	3.38±3.28	3.85±4.68	3.38±3.59	0.614
DML, anomaly [case(%)]	11(11)	9(9)	15(15)	0.404
DML(ms), ($\bar{x}$±s)	3.02±0.82	2.87±0.72	3.01±0.74	0.285
Velocity, anomaly [case(%)]	18(18)	14(14)	22(22)	0.338
Velocity(m/s), ($\bar{x}$±s)	64.58±18.52	68.79±16.83	64.11±15.33	0.101
Common Peroneal Nerve				
Amplitude, anomaly [case(%)]	41(41)	41(41)	50(50)	0.334
Amplitude(mv), ($\bar{x}$±s)	5.27±4.42	5.81±5.02	6.08±5.97	0.527
DML, anomaly [case(%)]	13(13)	16(16)	22(22)	0.226
DML(ms), ($\bar{x}$±s)	3.76±0.72	3.87±0.91	3.75±0.88	0.544
Velocity, anomaly [case(%)]	8(8)	5(5)	8(8)	0.631
Velocity (m/s), ($\bar{x}$±s)	65.93±16.26	64.69±17.08	67.86±16.98	0.408

Table 3: Comparison of electrophysiological examination results of the sensory nerve among Han, Hui and Xibe nationalities.

Differences in the proportion of patients with abnormal amplitude of various nerves, the mean value of the wave amplitude, the proportion of patients with abnormal distal incubation periods, the mean value of the distal incubation period, the proportion of patients with abnormal conduction velocity, and the mean value of speed of conduction among the three groups were not statistically significant. The specific results are presented in Table 3.

Discussion and conclusions

In the preset study, the clinical and electrophysiological features of primarily diagnosed IGT patients with PN in Han, Hui and Xibe nationalities were primarily analyzed, and differences in the clinical and electrophysiological features of IGT patients with PN in Han, Hui and Xibe nationalities were compared. In the aspects of clinical symptoms and signs, the main clinical symptoms were numbness of the limbs in all three groups, and the difference was not statistically significant. However, the proportion of patients with pressure hypesthesia and pallhypesthesia was significantly higher in Xibe nationality patients than in Han and Hui nationality patients, and the differences were statistically significant (P=0.008, P=0.000).

In addition, the proportion of patients with abnormal electrophysiological examination results was significantly higher in Xibe nationality patients than in Han and Hui nationality patients. The above-mentioned results further confirms that patients with peripheral neurologic symptoms and signs are more prone to abnormal electrophysiologic examination results.

The present study revealed that there are certain differences in the clinical manifestations and electrophysiological features of IGT patients with PN among ethnic minorities, and the results of the electrophysiological examination were helpful in identifying the pathological types of nerve injury: If the incubation period is prolonged or the velocity of conduction slows, it is suggested that the myelin sheath is involved, and the reduction or loss of amplitude suggests axonal damage. The results of the present study for all three groups suggest the following: the damage of the nerve of the lower limbs was significantly higher than that of the upper limbs; the damage of the sensory nerve was higher than that of the motor nerve: these mainly manifested as sensory axonal damages. These were consistent with those reported in literature[16-21]. The

possible mechanism is that the abnormal glucose metabolism induces the disorder of the synthesis of nutrient substance or axonal transport block in the body of neurons, causing the denaturation of the most distal axons due to the absence of necessary nutrients, which presents length dependence. That is, the longer the nerve is, the easier the involvement occurs, the earlier the clinical manifestation presents itself, and the more serious the symptoms of the distal extremities.

The present study has some limitations. The present study had a small sample size. Hence, the comparison of large sample data could not be performed. Furthermore, the examination of asymptomatic IGT patients with PD was not in depth, and the positive rate of the examination results was not significant. At present, there are few studies on the clinical and electrophysiological analysis IGT patients with PN in Hui and Xibe nationalities. In the present study, no related data could be used for reference and comparison. However, the present study was able to provide a reference for the further study of electrophysiological changes in the peripheral nerves between the ethnic minorities and the Han nationality.

This shall serve as a pave stone for large sample-size studies on the clinical electrophysiological characteristics of IGT patients with PN in ethnic minorities. At present, there is a lack of related information and data on IGT with PN in ethnic minorities. Hence, the reasons for the differences among ethnic groups needs to be further explored.

References

1) Advani A, Gilbert RE. The endothelium in diabetic nephropathy. Semin Nephrol. 2012; 32: 199-207.
2) Smith AG. Impaired glucose tolerance and metabolic syndrome in idiopathic neuropathy. J Peripher Nerv Syst. 2012; 17: 15-21.
3) Babaei-Ghazani A, Eftekharsadat B, Samadirad B, Mamaghany V, Abdollahian S.Traumatic lower extremity and lumbosacral peripheral nerve injuries in adults: Electrodiagnostic studies and patients symptoms. J Forensic Leg Med. 2017; 52: 89-92.
4) Yang W, Lu J, Weng J, Jia W, Ji L, Xiao J, Shan Z, Liu J, Tian H, Ji Q, Zhu D, Ge J, Lin L, Chen L, Guo X, Zhao Z, Li Q, Zhou Z, Shan G, He J; China National Diabetes and Metabolic Disorders Study Group. Prevalence of diabetes among men and women in China. N Engl J Med. 2010; 362: 1090-101.
5) Papanas N, Ziegler D. Polyneuropathy in impaired glucose tolerance: is postprandial hyperglycemia the main culprit? A mini-review. Gerontology. 2013;59:193-8.
6) Smith AG, Russell J, Feldman EL, Goldstein J, Peltier A, Smith S, Hamwi J, Pollari D, Bixby B, Howard J, Singleton JR. Lifestyle intervention for pre-diabetic neuropathy. Diabetes Care. 2006; 29: 1294-9.
7) PutzZ, TabákAG, TóthN, IstenesI, NémethN, Gandhi-RA, HermányiZ, KeresztesK, JermendyG, TesfayeS, KemplerP.Noninvasive evaluation of neural impairment in subjects with impaired glucose tolerance.. Diabetes Care. 2009; 32: 181-3.
8) Lee CC, Perkins BA, Kayaniyil S, Harris SB, Retnakaran R, Gerstein HC, Zinman B, Hanley AJ. Peripheral Neuropathy and Nerve Dysfunction in Individuals at High Risk for Type 2 Diabetes: The PROMISE Cohort. Diabetes Care. 2015; 38: 793-800.
9) Dyck PJ, O'Brien PC, Litchy WJ, Harper CM, Klein CJ, Dyck PJ. Monotonicity of nerve tests in diabetes: subclinical nerve dysfunction precedes diagnosis of polyneuropathy. Diabetes Care. 2005; 28: 2192-200.
10) Im S, Kim SR, Park JH, Kim YS, Park GYS. Assessment of the medial dorsal cutaneous, dorsal sural, and medial plantar nerves in impaired glucose tolerance and diabetic patients with normal sural and superficial peronealnerveresponses. Diabetes Care. 2012; 35: 834-9.
11) Goldberg A, Russell JW, Alexander NB. Standing balance and trunk position sense in impaired glucose tolerance(IGT)-related peripheral neuropathy. J Neurol Sci. 2008; 270: 165-71.
12) Smith AG, Ramachandran P, Tripp S, Singleton JR. Epidermal nerve innervation in impaired glucose tolerance and diabetes-associated neuropathy. Neurology. 2001; 57: 1701-4.
13) Milman S, Crandall JP. Mechanisms of vascular complications in prediabetes. Med Clin North Am. 2011; 95: 309-25.
14) Tesfaye S, Boulton AJ, Dyck PJ, Freeman R, Horowitz M, Kempler P, Lauria G, Malik RA, Spallone V, Vinik A, Bernardi L, Valensi P; Toronto Diabetic Neuropathy Expert Group. Diabetic neuropathies: update on definitions, diagnostic criteria, estimation of severity, and treatments. Diabetes Care. 2010; 33: 2285-93.
15) Tesfaye S, Selvarajah D. Advances in the epidemiology, pathogenesis and management of diabetic peripheral neuropathy. Diabetes Metab Res Rev. 2012; 28: 8-14.
16) Vinik A, Mehrabyan A. Diabetic neuropathies. Med Clin North Am. 2004; 88: 947-99.
17) Boulton A, Malik R. Diabetic somatic neuropathies. Diabetes Care. 2004; 27: 1458-80.
18) Tesfaye S, Chaturvedi N, Eaton SEM, Ward JD, Manes C, Ionescu-Tirgoviste C, et al. Vascular risk factors and diabetic neuropathy. N Engl J Med. 2005; 352: 341-50.
19) International Diabetes Federation. IDF Diabetes Atlas. 6th ed. 2013. Available from:http://www.idf.org/diabetesatlas
20) Khandoker AH, Jelinek HF, Moritani T, Palaniswami M. Association of cardiac autonomic neuropathy with alteration of sympatho-vagal balance through heart rate variability analysis. Med Eng Phys. 2009; 32: 161-7.
21) Spallone V, Ziegler D, Freeman R, Bernardi L, Frontoni S, Pop-Busui R, Stevens M, Kempler P, Hilsted J, Tesfaye S, Low P, Valensi P; Toronto Consensus Panel on Diabetic Neuropathy. Cardiovascular autonomic neuropathy in diabetes: clinical impact, assessment, diagnosis, and management. Diabetes Metab Res Rev. 2011; 27: 639-53.

Acknowledgements
We are particularly grateful to all the people who have given us help on our article.
Fund Project: The Xinjiang Uygur Autonomous Region Natural Science Foundation of Xinjiang special technical scientific research cooperation project for ethnic minority science and technology talents (201323133)

Corresponding Author:
Jia Huo
Department of Neurology, Xinjiang Yili Friendship Hospital,
No. 92 of Stalin Street ,
Yili, 835000, China
Email:huo332_df@163.com
(China)