Walking Strategy Abnormalities in Elderly with Diabetic Neuropathy: A Biomechanical Investigation through three Curves Analysis

Xi Pan[1,2], **Jiaojiao Bai**[1,2*], **Jiao Sun**[1,2], **Ran Wu**[1,2], **Yue Ming**[1,2], **Lirong Chen**[1,2] **and Zheng Wang**[1,2]

[1]*Depaertment of Nursing, Huadong Hospital Affiliated to Fudan University, Shanghai, China*

[2]*Clinical Key Laboratory of Geriatric Medicine, Shanghai, China*

*Corresponding author: Jiaojiao Bai, Department of Nursing, Huadong Hospital Affiliated to Fudan University, Shanghai, China, Tel: 86-021-13331806987; E-mail: bjj163163@163.com

Abstract

Objective: The aim of the present study was to explore the walking strategy by monitoring the characteristics of plantar pressure in elderly patients with diabetic peripheral neuropathy.

Methods: This descriptive study was conducted at the endocrine ward at Huadong Hospital, Fudan University, shanghai, China, from April 2016 to December 2016. Elderly patients with diabetic peripheral neuropathy were enrolled from Huadong Hospital, Fudan University. Non-diabetes elderly were enrolled from Changning District Xianxia Street Community Service Center, Shanghai, China. A total of 229 participants were recruited. Non-diabetic elderly were grouped for DC, and elderly with type 2 diabetes, according to the Toronto clinical neuropathy score (TCSS) into no significant peripheral neuropathy group (DM group), mild peripheral neuropathy group (DN_1 group), moderate peripheral nerve lesion group (DN_2 group) and severe peripheral neuropathy group (DN_3 group), a total of five groups. Outcome measures included the center of pressure (COP)　the plantar force time curve, the Foot balance curve and loading time.

Results:

COP trajectories: The COP trajectories in elderly with DPN were abnormal significantly with abnormal foldback, beginning point shifted forward and terminal point lateral shifted; The COP excursions along the medio-lateral axes reduced in elderly with DPN and increased in elderly without PN; The COP excursions and maximum excursions along the longitudinal reduced in elderly with DPN; The COP minimum excursions along the longitudinal axis increased in elderly with DPN, with the most severe PN significantly ($p < 0.05$).

The plantar force time curve: The plantar force time curve were abnormal significantly in mild and severe PN with single more force peak; Among the morphologically normal curves, the first and second peak force reduced in elderly DM with PN and without PN. The time to peak and valley in elderly DM with PN and without PN delayed ($p < 0.05$).

Foot balance: The Foot balance curve were abnormal significantly, with no positive wave or negative wave, with the most severe PN significantly. Among the morphologically normal curves, the positive and negative peak values reduced in elderly with DPN ($p < 0.05$).

M fngit fd ɦe ʝme M M MMaghpaɼson fɡꓭibma M M thth nPN Mnithout MnYvere nN Mꓤɡnificant nP005)Ꞧe ꞦYme Mnhe nhildb

e purpose of this study was to monitor the characteristics of COP and explored the walking strategy by measuring dynamic barefoot plantar pressure in elderly patients with type 2 diabetes. is would assist in providing the basis for the establishment of abnormal plantar pressure correction system, stability of their gait and reducing occurrence of falls.

Gi V"YWg UbXA Yh\cXg

Gi V"YWg

is study was conducted at the endocrine ward at Huadong Hospital, Fudan University, shanghai, China, from April 2016 to October 2016. Two trained diabetes specialist nurses were responsible for the enrollment of the elderly patients with type 2 in Huadong Hospital, Fudan University. Another two trained diabetes specialist nurses were responsible for the enrollment of the non-diabetes elderly in District Xianxia Street Community Service Center, Shanghai, China. A total of 229 participants were recruited. Non-diabetic elderly were grouped for DC, and elderly with type 2 diabetes, according to the Toronto clinical neuropathy score (TCSS) into no signif cant peripheral neuropathy group (DM group), mild peripheral neuropathy group (DN$_1$ group), moderate peripheral nerve lesion group (DN$_2$ group) and severe peripheral neuropathy group (DN$_3$ group), a total of f ve groups. For the selection of the sample, the following factors were considered as inclusion criteria: the diagnosis of type 2 diabetes under stable metabolic control; age older than 60, capability to remain in an orthostatic position without assistance or the use of auxiliary devices; Individuals with current foot ulcer, bilateral foot amputations, wheelchair-bound or unable to walk, too sick to participate, or psychiatric illness that prevented informed consent were excluded. All subjects provided informed consent prior to participating in the study.
e

BMI(kg/m^2)	23.5 ± 2.4	20.3 ± 9.0	23.6 ± 5.3	22.0 ± 9.2	22.9 ± 5.1	1.643	1.164
WHR	0.8 ± 0.1	0.7 ± 0.3	0.8 ± 0.2	0.8 ± 0.2	0.8 ± 0.3	1.237	0.296
Foot length(cm)	21.7 ± 1.9						

Group	Cases (n)	A single peak	More than one peak
DC	65	6(9.2)	7(10.8)
DM			

@cUX]b[ḩa Y

Loading time was signif cantly longer in the severe pain. In the stance phase of gait cycle, the time of midstance phase were longer, and the time of heel contact phase and propulsion phase were shorter in elderly with DPN and without DPN, with moderate and severe PN more signif cant (p<0.05); e loading time of the whole foot were prolonged and advanced, the loading time of midfoot and heel were shorten (p<0.05) (Table 7).

Group	T1	T2-5	M1	M2	M3	M 4	M5	MF	HM	HL
DC	43.9 ±2 8.9	34.8 ± 25.9	19.1 ± 15.4	45.3 ± 27.5	51.6 ± 20.7	50.8 ± 24.8	30.7 ± 26.7	8.5 ± 1.4	3.4 ± 1.9	4.3 ± 1.5
DM	46.9 ± 24.1	22.4 ± 18.2	39.8 ± 24.4a	39.6 ± 19.3	34.8 ± 16.8a	42.2 ± 17.2	44.4 ± 26.1	15.1 ± 12.0	0.8 ± 0.5	1.1 ± 0.7
DN$_1$	45.1 ± 28.9	38.6 ± 28.6	35.2 ± 28.4[a]	36.2 ± 21.9[ab]	31.5 ± 21.6[a]	31.8 ± 23.8[a]	27.3 ± 18.4[b]	14.9 ± 8.7	4.3 ± 2.7	3.9 ± 1.2
DN$_2$	34.6 ± 26.4[abc]	22.4 ± 10.5	28.8 ± 24.6[ab]	28.4 ± 20.8[a]	26.9 ± 17.8[a]	34.9 ± 23.0[a]	20.9 ± 10.3[b]	15.1 ± 8.7	2.7 ± 1.4	

and the stability of the ground reduced. At the same time, leading to the body center of gravity forward, supporting period stability decreased and risk of falls increased.

7cbWïgjcb

e walking strategy in elderly with DPN were abnormal including shortage driving force, poor lateral stability, li o outwards and f at-footed contact. Proprioception training, personalized ankle brace,