MULTIVARIATE CONSERVATIVE GAIT PATTERN IN DIABETES

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INTRODUCTION

Patients with diabetes and peripheral neuropathy (DMPN) exhibit gait instability. While appearing trivial, gait unsteadiness demonstrated a strong association with depressive symptoms. Fearful walkers adopt a slower walking speed, shorter stride length, and longer double support time than fearless walkers. Similar gait patterns have been described in patients with diabetes and DMPN patients. While intuition suggests patients with diabetes adopt a more conservative gait pattern to make them feel more stable, they remain at higher risk for falls. A recent study accounted for multiple domains of falls and diabetes, gait, and balance remained as significant independent predictors in the final model.(Maurer, Burcham et al. 2005) The purpose of this study is to use a multivariate approach to describe the conservative gait pattern in diabetes patients.

METHODS AND PROCEDURES

This study took place from July 2000 to May 2001 at the Veterans Affairs Medical and Regional Office Center, White River Junction, VT. Male patients with diabetes without a history of foot surgery were asked to enroll. Two examiners were trained to assure standardization of exam techniques. Inter-rater reliability of ankle and 1st metatarsal phalangeal joint (1st MPJ) motion was 0.71 and 0.95 respectively. Apropulsive gait was defined visually by the absence of ankle plantarflexion during the propulsive phase of gait. Maximum peak plantar pressures were measured using the F-Scan mat system, version 4.12F (Tekscan, Boston, MA) using the average of five steps. The sampling frequency was 50 Hz. For univariate analyses, Fisher's Exact Test was used for dichotomous data and oneway analysis of variance for continuous data. The multivariate model was built using a forward stepwise logistic regression. Of the 152 patients, 40 patients exhibited the conservative gait pattern. Based on this, we nominated 4 *A Priori* covariates for our regression model.(age, neuropathy, and range of motion at the ankle and 1st MPJ)

RESULTS

Patients with the conservative gait pattern had lower walking speed and decreased stride length compared to normal gait.(0.68 m/s v. 0.91 m/s, p=0.0000; 1.04 m v. 1.24 m, p=0.0000) Age, neuropathy, and Romberg's sign were significantly higher; and ankle mobility was significantly lower in the conservative gait pattern group.(Table) In the multivariate analysis; age, ankle joint mobility, and callus were retained in the final model. This model described 17% of the variance. In a stepwise fashion, age described 8.2% of the variance. Ankle joint mobility and callus described 3.4% and 1.4% of the variance respectively.

DISCUSSION

The prevalence of conservative gait in our cohort of elderly diabetic veterans was 26%. Thinking that neuropathy would lead to fearful walking, we were surprised that neuropathy was not retained in the model. We were equally surprised that Romberg's

sign was not retained as this may represent more advanced neuropathy. These findings are also supported by Mueller and colleagues.(Mueller, Minor et al. 1994) Our approach addressed invited commentary to Mueller et al. suggesting that neuropathy-free and patients not affected by foot ulcer treatment be included. Our study has limitations. The cross-sectional design and secondary analyses make causal attribution problematic. Neuropathy definitions were coarse. This study has clinical implications for callus care and exercise training in this population. (Richardson, Sandman et al. 2001; Balducci, Iacobellis et al. 2006)

SUMMARY

The results of our multivariate analysis of conservative gait in diabetes patients suggest that benefits previously observed from exercise training DMPN patients might be from increased ankle mobility or strengthening rather than reversal of lost sensory afferent deficits.

References

Balducci, S., G. Iacobellis, et al. (2006). "Exercise training can modify the natural history of diabetic peripheral neuropathy." J Diabetes Complications **20**(4): 216-23.

Maurer, M. S., J. Burcham, et al. (2005). "Diabetes mellitus is associated with an increased risk of falls in elderly residents of a long-term care facility." J Gerontol A Biol Sci Med Sci **60**(9): 1157-62.

Mueller, M. J., S. D. Minor, et al. (1994). "Differences in the gait characteristics of patients with diabetes and peripheral neuropathy compared with age-matched controls." Phys Ther **74**(4): 299-308; discussion 309-13.

Richardson, J. K., D. Sandman, et al. (2001). "A focused exercise regimen improves clinical measures of balance in patients with peripheral neuropathy." Arch Phys Med Rehabil **82**(2): 205-9.

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Descriptive characteristics	Conservative Gait	Normal Gait	p-value
N	40	264	
Age (mean yrs)	73.1	66.2	0.0000
Insulin (% yes)	36	28	0.3450
HgbA1c (%)	7.89	7.64	0.2896
DM Duration (mean yrs)	9.5	10.1	0.7272
Smoking History(% yes)	92	82	0.1126
Height (mean inches)	68.5	68.4	0.9505
Weight (mean lbs)	212	211	0.8497
1st MPJ ROM (mean degrees)	12.1	14.2	0.1344
Bunion deformity (% yes)	18	17	1.0000
Hammer toe (% yes)	51	37	0.1142
Non-palpable pulse (% yes)	59	43	0.0599
Monofilament insensitivity (%)	46	27	0.0223
Absent joint position sense (%)	5	2.6	0.3450
Ankle ROM (mean degrees)	3.6	5.6	0.0059
Callus (% yes)	49	36	0.0793
Fat pad atrophy (% yes)	31.4	47.1	0.1158
Stride length (mean meters)	1.04	1.24	0.0000
Walking speed (mean m/s)	0.68	0.91	0.0000
Peak Pressure (kg/cm^2)	3.81	3.87	0.7449