The effects of isometric exercises and stretching on postural stability in Non–Insulin Dependent Diabetes Mellitus patients with diffuse symmetrical sensory motor neuropathy

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ABSTRACT:
The purpose of this study was to explore the effects of isometric exercises and stretching on postural stability in Non – Insulin Dependent Diabetes Mellitus (NIDDM) patients with diffuse symmetrical sensory motor neuropathy. Patients were assigned to an experimental group and a matched control group. The experimental group received isometric exercises and stretching three times weekly for 12 weeks in addition to routine medication and dietary advice. At the end of this period, this group was compared with the control group, which received routine medication and dietary advice only. Measurements of muscle strength of quadriceps, hamstrings, ankle plantar and dorsiflexors, and Romberg's test for postural stability were carried out before and after the 12 weeks intervention. The study showed that isometric exercises and stretching for the lower extremities improved postural stability (p = 0.00) and strength of the quadriceps (p = 0.001) hamstrings (p = 0.001) dorsiflexors (p = 0.001) plantarflexors (p = 0.001) in NIDDM patients with diffuse symmetrical sensory motor neuropathy. This exercise regimen also had a lowering effect on blood glucose level (p = 0.00). In conclusion it seems that the simple exercise intervention described in this study may be of benefit to these patients if incorporated into their management programmes.

KEYWORDS: DIABETIC PERIPHERAL NEUROPATHY; ISOMETRIC EXERCISE; STRETCHING; POSTURAL STABILITY

BACKGROUND

Diabetes and its complications are significant causes of morbidity and mortality in the world. The South African national burden of disease study, 2000, ranks the top 20 diseases contributing to the greatest disease burden (Bradshaw et al, 2000). Diabetes mellitus is twelfth in the rank of diseases responsible for premature death and sixteenth as a cause of disability adjusted life years (Bradshaw et al, 2000). Among the most common of the long-term complications of diabetes, are those affecting the peripheral nervous system. Diffuse symmetrical sensory motor neuropathy occurs in Insulin Dependent, Non-Insulin Dependent and in the secondary forms of diabetes (Boulton et al, 2004). Reported prevalence ranges between 10 – 90% of an unselected diabetic population and diabetic neuropathy increases with worsening hyperglycaemia.

Symmetrical sensory loss in the distal lower extremities is the most common manifestation of diffuse sensory motor neuropathy. Nerve loss affects small unmyelinated and myelinated fibres first, causing a reduction in pain and temperature sensation (Boulton et al, 2004).

Distal symmetrical polyneuropathy is one of the most important predictors of ulcers and amputation due to atrophy and weakness of the small foot muscles which change the biomechanical properties of the feet, resulting in increased foot pressures during weight bearing (American Diabetes Association, 2001a). Older persons with peripheral neuropathy are at an increased risk for falls due to postural instability when compared to older persons with healthy peripheral nerves (Richardson et al, 2001). The same authors identified that the causes of postural instability in older persons with peripheral neuropathy are distal sensory and motor impairments. The strength of the ankle and knee extensors and flexors, and the movements of the ankle have been found to be moderately impaired in long- term Insulin Dependent and Non-Insulin Dependent Diabetes Mellitus patients (Boulton et al, 2004). All these changes lead to an abnormal walking pattern in neuropathic patients. They demonstrate a shift from physiological ankle control

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to hip postural control (Giacomini et al, 1996). Diabetic patients with sensory motor neuropathy use hip postural control due to the loss of proprioceptive inputs from the ankle joints.

Although the metabolic effects of exercise on diabetes have been investigated thoroughly (American Diabetes Association 2001c), there is very little documented about the effect of exercise on postural stability in patients with diabetic neuropathy. It is not known whether isometric exercises and stretching will improve balance and postural stability in patients with distal symmetrical sensory motor neuropathy.

METHOD

Study design

This was a prospective, experimental study with an experimental and a matching control group that fitted the inclusion criteria listed below. The control group was matched for the stage of neuropathy and as far as possible for gender and age.

Subjects

A convenience sample meeting the inclusion criteria listed below was drawn from the Middelburg General Hospital chronic diseases clinic, Mpumalanga Province and "St. Joseph" Old Age Home (Middelburg) South Africa. Ethical clearance was obtained from the Committee for Research on Human Subjects (Medical) of the University of the Witwatersrand, Johannesburg. All subjects gave consent to participate in the study.

Inclusion criteria:

- Subjects between 40 – 70 years old
- Female and male
- Non – Insulin Dependent Diabetes Mellitus
- Diffuse symmetrical sensory motor neuropathy
- Ability to walk without assistance or a walking aid
- Strength of knee and ankle muscles grade 3 (antigravity) or greater by manual muscle testing

Exclusion criteria:

- Uncontrolled diabetes mellitus (fluctuating blood glucose levels: less than 5.5 mmol/l and more than 14 mmol/l (99 and 252 mg/dl)
- Retinopathy
- Coronary artery disease and a history of angina or angina – equivalent symptoms
- Uncontrolled hypertension (systolic > 160 mmHg and diastolic > 90 mmHg)
- Autonomic neuropathy
- A history of central nervous system dysfunction i.e. hemiparesis, myelopathy, cerebellar ataxia
- Musculoskeletal deformity: amputation, scoliosis, and inability to actively move ankle and knee joints in all directions
- Lower extremity arthritis or pain that limited standing
- A history or evidence on physical examination of vestibular dysfunction
- Foot ulcer at the time of examination

Sample size

A sample size of 20 per group gave a power of 80% using a change in Romberg's test of 7 (±7 secs) and allowing for a 15% drop out from the exercise intervention.

Procedure

A medical officer performed the initial clinical examination. The recommendations of the San Antonio conference were used to diagnose diffuse symmetrical sensory motor neuropathy (American Diabetes Association, 2001b). The clinical examination included: general medical and neurological history of the patient and neurological examination (ability to perceive the touch of a 10-gram monofilament on the plantar surface of the hallux and centrally at the heel; ability to sense a 128 Hz tuning fork on the great toe; pinprick sensation at the great toe; ability to identify the joint position of the toe; Achilles reflex; strength of knee and ankle flexors and extensors; and cardiac autonomic neuropathy tests). The results of the examination were used to determine the stage of diabetic neuropathy in the system proposed by Dyck et al, (1991):

0– No Neuropathy: No symptoms and fewer than two abnormalities on testing (including autonomic function test).

1– Asymptomatic Neuropathy: No symptoms but two or more abnormalities on testing.

2– Symptomatic Neuropathy: Minor symptoms with two or more abnormalities.

3 — Disabling Neuropathy: Severe symptoms with two or more abnormalities.

The subjects in the experimental group received 45 minutes of isometric exercises and stretching, 3 times a week for 12 weeks, in addition to their oral hypoglycaemic medication and dietary recommendations. The exercises were done in a class in non-weight bearing positions i.e. lying, long sitting and cross sitting.

The exercise programme was as follows:

The exercises started with a 10 minute "warm up" session consisting of stretching for the muscles of the toes, ankles and knees. Each stretch was held for 20 seconds and repeated twice on each side. Subjects were instructed not to hold their breath during stretching and to do the stretching slowly so as to avoid pain.

Isometric exercises were then done for the muscles of the lower extremities, namely the quadriceps, hamstrings, plantarflexors and dorsiflexors. The isometric 'hold" was held for five seconds and this was followed by 10 seconds of relaxation. Each exercise was repeated six times. Subjects were instructed not to hold their breath and to do the isometric exercises rhythmically. This part of the exercise programme lasted for 25 minutes.

The exercise sessions were concluded with "cooling down" using stretching exercises for the knee and hip muscles. The stretch was held for 20 seconds and repeated twice on each side.

Subjects in the control group received their routine oral hypoglycaemic medication and their dietary recommendations. Control subjects came to the hospital for all testing at the beginning and at the end of the study i.e. after 12 weeks.

Romberg's test for postural stability and the muscle strength of the quadriceps, hamstrings, dorsiflexors and pantarflexors were measured at the beginning and the end of the study by the first author. The muscle strength was established using a hand held dynamometer and the best of three measures was recorded. Blood glucose levels, blood pressure and heart rate were measured before and 3 minutes after each treatment session by an attendant nursing sister. The intrarater reliability of the first author conducting Romberg's test as well as the muscle strength tests was established on a group of five patients and repeated five days later on the same subjects prior to the commencement of the study.

Statistical analysis

This study was conducted as a two arm, controlled, parallel, intervention study comparing subjects undergoing an exercise intervention to control subjects who did not receive an exercise intervention.

The primary outcome variables were postural stability measured in seconds by Romberg's test and muscle strength in kilograms of force measured using a dynamometer. The secondary outcome variables were blood glucose levels in mmol/l; blood pressure in mm/Hg; and heart rate in beats/min.

Non-parametric data were analysed by using Fisher's exact test and parametric data were analysed by using the two-sample t-test for comparisons between groups. An analysis of covariance (ANCOVA) was done to compare the experimental and control groups with respect to changes from baseline. Testing was done at the 0.05 level of significance using Stata V7 statistical software.

RESULTS

Twenty subjects from the experimental group and twenty subjects from the control group completed the study. Six subjects from the intervention group missed one exercise session there fore attending 35 sessions, and six subjects missed two exercise sessions therefore attending 34 exercise sessions. Reasons for missing sessions ranged from having head colds to transport difficulties. The rest of the group i.e. eight subjects attended 36 exercise sessions (3 times a week for 12 weeks). Exercise related injuries were not reported. Hypoglycaemic incidents were not observed during or after the exercise intervention.

There was no significant difference in age, gender, race and stage of neuropathy between the experimental and control groups (Table 1). The major indicator for recruitment of patients in this study was the stage of diabetic diffuse symmetrical sensory motor neuropathy because the subject of the study was one of its manifestations namely, postural instability. The duration of NIDDM and duration of diabetic neuropathy do not always correlate with the stage of neuropathy (American Diabetes Association, 2001b). So the significant differences at baseline for the duration of NIDDM and duration of neuropathy do not affect the study outcomes.

Table 2 shows the changes in Romberg's test and muscle strength before and after 12 weeks. Romberg's test improved significantly in the exercise group relative to the control group (p=0.001). The strength of the quadriceps, hamstrings, dorsiflexors and plantarflexors were substantially improved in the exercise group relative to the control group (p=0.001).

The blood glucose level decreased on average by 3.7 mmol/l in the exercise group, and increased by 0.9 mmol/l in the control group during the intervention (p = 0.00). There was a significant reduction in resting systolic blood pressure in the exercise group and there were no changes in resting systolic blood pressure in the control group (p = 0.003). The changes in resting diastolic blood pressure were not significantly different between groups (0.13). There was not a significant difference in the change in resting heart rate (p = 0.89) during the intervention between groups.

DISCUSSION

The main finding of this study is that a special regimen of isometric exercises and stretching for the lower extremities

Table 1: Demographic characteristics of subjects.

Subject characteristics	Experimental group (n=20)	Control group (n=20)	p - Values
Age (years)	59.6 (± 9.4) (41-70)	58.9(± 6.2) (48-69)	NS
Gender: female male	 14 6	 12 8	 NS
Race: black| Indian white	 12 0 8	 10 2 8	 NS
Stage of Neuropathy: 2nd 3rd	 19 1	 19 1	 NS
Duration of NIDDM (years)	11.5 ± 6.7 (5-20)	7.8 ± 4.6 (2-16)	0.04*
Duration of Neuropathy (years)	6.3 ± 4.4 (2-15	3.8 ± 2.5 (1-10)	0.04*

Note: Values presented as mean ± SD; the ranges are given in brackets.
n = number of subjects in the group NS = Not Significant * = Significant

Table 2: Romberg's test and muscle strength data pre and post intervention.

Dependent variable	Before	After	Change form baseline to post intervention	p-Value
Romberg's test (sec) EG (n = 20) CG (n = 20)	 10.7 ± 7.1 13.05 ± 6.3	 18.25 ± 9.0 11.45 ± 5.1	 + 7.55 - 1.6	 0.001*
Quadriceps (kg/force) right (EG, n=20) right (CG, n=20)	 9.6 ± 1.6 11.0 ± 2.3	 10.58 ± 1.8 10.96 ± 2.3	 + 0.98 - 0.04	 0.001*
left (EG, n=20) left (CG, n=20)	8.8 ± 1.9 9.84 ± 2.1	10.0 ± 2.0 9.82 ±2.1	+ 1.2 - 0.02	0.001*
Hamstrings (kg/force) right (EG, n=20) right (CG, n=20)	 7.5 ± 1.9 8.3 ± 2.2	 8.5 ± 1.8 8.31 ± 2.2	 + 1.0 + 0.01	 0.001*
left (EG, n=20) left (CG, n=20)	6.9 ± 2.0 7.55 ± 2.3	8.02 ± 2.0 7.56 ± 2.3	+ 1.12 + 0.01	0.001*
Dorsiflexors (kg/force) right (EG, n=20) right (CG, n=20)	 4.9 ± 1.0 6.11 ± 1.5	 5.7 ± 1.0 6.1 ± 1.5	 + 0.8 - 0.01	 0.001*
left (EG, n=20) left (CG, n=20)	4.4 ± 1.0 5.7 ± 1.5	5.2 ± 1.0 5.7 ± 1.5	+ 0.8 0.0	0.001*
Plantarflexors (kg/force) right (EG, n=20) right (CG, n=20)	 6.2 ± 0.9 7.1 ± 1.7	 7.0 ± 0.8 7.0 ± 1.7	 + 0.8 - 0.1	 0.001*
left (EG, n=20) left (CG, n=20)	5.8 ± 0.9 6.5 ± 1.7	6.6 ± 0.8 6.48 ± 1.7	+ 0.8 - 0.02	0.001*
left (EG, n=20) left (CG, n=20)	37.6 ± 5.4 37.5 ± 4.0	38.4 ± 5.5 37.5 ± 4.0	+ 0.8 0.0	0.001*

Note: Values presented as mean ± SD; p – values of the change (ANCOVA);
EG = Experimental Group; CG = Control Group; n = number of subjects in the group; * = Significant.

Table 3: Blood glucose level, blood pressure and heart rate data pre and post intervention.

Dependent variable	Before	After	Change form baseline to post intervention	p-Value
Blood glucose level (mmol/l) EG (n=20) CG (n=20)	 9.9 ± 1.1 8.6 ± 1.9	 6.2 ± 0.7 9.5 ± 1.5	 - 3.7 + 0.9	 0.00*
Blood pressure (mmHg) systolic (EG, n=20) systolic (CG, n=20)	 141.0 ± 15.2 139.5 ± 12.8	 130.0 ± 7.9 139.5 ± 12.3	 - 11.0 0.0	 0.003*
diastolic (EG, n=20) diastolic (CG, n=20)	79.5 ± 8.3 82.5 ± 7.9	77.0 ± 5.7 83.0 ± 6.6	- 2.5 + 0.5	0.13 (NS)
Heart rate (beats/min) EG (n=20) CG (n=20)	 74.4 ± 5.1 76.3 ± 4.6	 74.3 ± 4,2 76.3 ± 4.6	 - 0.1 0.0	 0.89 (NS)

Note: Values presented as mean ± SD; p – values of the changes (ANCOVA); EG = Experimental Group;
CG = Control Group; n = number of subjects in the group;
NS = Non Significant; * = Significant.

can improve postural stability as measured by Romberg's test in patients with diabetic peripheral neuropathy. This agrees with the findings by Richardson at al, (2001). The reason why their patients showed an improvement in three commonly used measures of balance (functional reach, tandem stance, unipedal stance) was, as they suggested, most probably because the subjects improved their available ankle strength, which provides torque to the ankle. They concluded that an isolated improvement in the strength of the ankle musculature would likely be sufficient to lead to the improvements noted in their study. This appears to have been a reasonable conclusion because as the results for this study show, there was both an improvement in muscle strength and postural stability in these subjects.

An improvement in ankle muscle strength, might also improve ankle propriceptive thresholds hence postural stability in diabetics with peripheral neuropathy (Richardson et al, 2001). This study shows that muscle strengthening together with increased proprioceptive thresholds may be equally important for postural stability. An improvement in proprioceptive input may be achieved by other techniques in addition to muscle strengthening. In this study stretching was used as well in order to increase the ankle proprioceptive threshold. As mentioned by Fremerey et al, (2001), extensive stretching may stimulate various mechanoreceptors which can boost the proprioceptive awareness and hence postural stability.

Isometric exercises and a stretching programme applied to the lower limbs increased the available strength of quadriceps, hamstrings, dorsiflexors and plantarflexors. Considering the length of this study design (12 – week intervention) the strengthening that occurred in the experimental group may have been related to a synchronisation of motor units and muscle hypertrophy as well. The improved synchronisation of motor units may be related to neural changes and appears early in muscle strength gains (Richardson et al 2001; White et al, 2004).

There was a significant decrease in blood glucose levels during the isometric exercises and stretching programme. At the end of the study patients in the experimental group had blood glucose levels close to normal. This observation agrees with the findings by Castaneda et al, (2002). The blood glucose lowering effect of isometric exercises and stretching supports the American Diabetes Association, (2001c) recommendations that long-term exercise programmes are important for the treatment and prevention of NIDDM.

Other than a reduction in systolic blood pressure in the experimental group at the end of the intervention there were no changes in blood pressure and heart rate.

CONCLUSION

The isometric exercises and stretching programme for the lower extremities improved postural stability and motor function in patients with diabetic symmetrical sensory motor neuropathy. This exercise regimen had a lowering effect on blood glucose level as well.

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Research

Article

The perceptions, attitudes and knowledge of physiotherapy and chiropractic students regarding each others' professional practice

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ABSTRACT: Introduction: *The roles of physiotherapists and chiropractors demonstrate some overlap. Both are members of a multidisciplinary team and contribute to the holistic care of patients. Good understanding of each others' professional practice may lead to good working relationships with effective referrals, interdisciplinary and multidisciplinary management of patients.*

Purpose: *To investigate the perceptions, attitudes and knowledge of undergraduate physiotherapy and chiropractic students about each others' professional roles in clinical practice.*

Methodology: *Data was obtained using a questionnaire with closed and open-ended questions. First and final-year physiotherapy (n = 72) and chiropractic students (n = 49) participated.*

Results: *First and final year physiotherapy students scored 58% and 62% respectively in the "test" on chiropractic; chiropractic students scored 52% and 68% respectively in the test on physiotherapy. Seventy percent of the chiropractic and 14% of the physiotherapy students had visited the practice of other profession. Sixty seven percent of the chiropractic and 38% of the physiotherapy students found it was effective. Forty seven percent chiropractic and 80% physiotherapy students considered physiotherapy and chiropractic to be in direct competition. Sixty six percent of the chiropractic students and 49% of the physiotherapy students expressed the intention of working together with the other profession.*

Discussion: *The reason for the possible feelings of competitiveness could be because in South Africa there is vast overlap of practice in both professions; Physiotherapists and chiropractors are seen to use modalities that are similar. This may be viewed as an indication of the importance in defining the roles, scope and characteristics of both physiotherapy and chiropractic.*

Conclusion: *The knowledge of the physiotherapy and chiropractic students is equal, however, chiropractic students have more positive perceptions and attitudes towards physiotherapy than physiotherapy students have of chiropractic.*

KEYWORDS: PHYSIOTHERAPY, CHIROPRACTIC, HEALTH KNOWLEDGE, ATTITUDES, PROFESSIONAL PRACTICE.

1. INTRODUCTION

A characteristic of any profession is that it occupies a social standing relative to other professions (Turner, 2001). The professional relationship between physiotherapists and chiropractors is important as both physiotherapists and chiropractors are members of a multidisciplinary team and contribute to the holistic care of patients. Understanding the perceptions and attitudes of undergraduate students, (who are a key target because they are future practitioners), would help the profession create more effective marketing strategies, knowing the misconceptions that need to be corrected (Prati and Liu, 2006). This study was undertaken to determine the perceptions, attitudes and knowledge that Physiotherapy and chiropractic students have of each others' professional practice.

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1.1 Physiotherapy Education and Practice

Physiotherapy is concerned with 'assessing, treating and preventing movement disorders, restoring normal function or minimising dysfunction and pain in adults and children with physical impairment, to enable them to achieve the highest possible level of independence; preventing recurring injuries and disability in the workplace, at home, or during recreational activities and promoting community health for all age groups (South African Society of Physiotherapy, 2008). Physiotherapists use 'skilled evaluation, skilled hands on therapy such as mobilisation, manipulation, massage and acupressure; individually designed exercise