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Pelvic Floor Muscle Training Is Effective in Women With Urinary Incontinence After Stroke: A Randomised, Controlled and Blinded Study

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Aims: The aim of this study was to evaluate the effect of Pelvic Floor Muscle Training (PFMT) in women with urinary incontinence (UI) after ischemic stroke. **Materials and Methods:** Three hundred and thirty-nine medical records of stroke patients were searched. Twenty-six subjects were randomised to a Treatment Group (14 subjects) or a Control Group (12 subjects) in a single blinded, randomised study. The intervention included 12 weeks of standardised PFMT. The outcome measures were: (1) diary recording the frequency of voiding, the number of incontinence episodes and used pads; (2) 24-hr home pad test; and (3) vaginal palpation of pelvic floor muscle evaluating function, strength, static and dynamic endurance. **Results:** Twenty-four subjects with urge, stress and mixed stress/urge incontinence, completed the study, 12 in each group. A significant improvement in frequency of voiding in daytime (Treatment Group/Control Group: 7/8 at pre-test, 6/9 at post-test (median values), $P = 0.018$), 24-hr pad test (Treatment Group/Control Group: 8/12 to 2/8 g $P = 0.013$) and dynamic endurance of pelvic floor muscle (Treatment Group/Control Group: 11/20 to 20/8 contractions of Pelvic Floor Muscle, $P = 0.028$) was demonstrated in the Treatment Group compared to the Control Group. A significant improvement in frequency of voiding in daytime (decreased from seven to six, $P = 0.036$), pelvic floor muscle function ($P = 0.034$), strength ($P = 0.046$), static endurance increased from 9 to 30 sec ($P = 0.028$) and dynamic endurance increased from 11 to 20 contractions ($P = 0.020$) was also demonstrated within the Treatment Group, but not in the Control Group. **Conclusion:** PFMT had a significant effect in women with UI after stroke measured by diaries, pad tests and vaginal palpation. *Neurourol. Urodynam. 24:348–357, 2005.* © 2005 Wiley-Liss, Inc.

Key words: pelvic floor muscle training; physical therapy; stroke; urinary incontinence; women

INTRODUCTION

Urinary incontinence (UI) [Abrams et al., 1990] after stroke seem to have a low priority in the medical society [Henriksen, 1993], despite the prevalence varying from 12% to 79% depending on time since stroke [Brittain et al., 1998; Patel et al., 2001; Kolominski-Rabas et al., 2003] and despite the fact that UI in community-based population has negative consequences such as decreased quality of life [Noelker, 1987; Grimby et al., 1993], high socioeconomic costs [Milsom et al., 1989] and time spent by the nursing staff [Steel and Fonda, 1995].

Treatments of UI after stroke include pharmacological treatment although it often produces numerous side effects and further developments are needed [Andersson, 2000; Fowler, 2000]. Behavioural treatment such as timed voiding [Fantl et al., 1991] and for more immobile and not cooper able patients pads or catheters have been used. Surgery is only rarely indicated for neurological patients [Lum and Marshall, 1982].

The Agency of Health Care Policy and Research's Clinical Practice Guidelines on Urinary Incontinence in Adults

Abbreviations: PFM, pelvic floor muscle; PFMT, pelvic floor muscle training; UI, urinary incontinence.

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update advises that "the least invasive and least dangerous procedure that is appropriate for a patient should be the choice" when treating UI [Fantl et al., 1996].

Pelvic Floor Muscle Training (PFMT) [Abrams et al., 1990] have been used in treatment of UI in non-neurological female patients since 1948 [Kegel, 1948] and the effect rate varies from 23% to 94% depending on the method, the population and type of incontinence [Klarskov et al., 1986; Bø, 1990; Nygaard et al., 1996; Hay-Smith et al., 2002].

The aim of the training procedure is to improve pelvic floor muscle (PFM) function. The treatment consists of muscle awareness training, training of strength and coordination. By cerebral cortical facilitation (motor learning) the number of motor units may also increase [Sale, 1988], which again can improve the PFM function.

UI after stroke is as far as we know caused by a lack of central bladder inhibition [Wein and Rovner, 1999]. In stroke the dysfunction is caused by a focal brain damage due to ischemia or haemorrhage. When the brain damage is located to a small area in the right frontal region of cerebrum, which controls the micturition, it may result in bladder overactivity and UI of urge type [Groat, 1997], but also other lesions in the brain may result in urge UI. More detailed pathophysiological studies of focal lesions in relation to UI are lacking.

Physical therapy is a very important part of the rehabilitation of stroke patients but no clear consensus exists concerning which techniques or methods are the best [Andersen et al., 2001]. Even though studies have shown that occurrence of UI is a predictor for poor rehabilitation [Ween et al., 1996], it is unknown whether stroke patients with UI can be rehabilitated.

So far as we know, no other study has focused on objective measures within rehabilitation of UI in stroke, although physical treatment has been shown to be effective in stroke patients in general and PFMT has been shown to be effective in non neurological women with UI. The aim of this study was to evaluate the effect of PFMT in women with UI after stroke.

MATERIALS AND METHODS

The present study constitutes one part of a multifaceted study about general effect of PFMT where one article focusing on quality of life has been published [Tibaek et al., 2004].

Subjects

The sample was recruited from four clinical departments at Copenhagen University Hospital, Glostrup (acute stroke unit, neurological, geriatric, rehabilitation), the general physical therapy clinic and the public rehabilitation centres in The Copenhagen County from January 1st 1999 to March 1st 2001.

The inclusion criteria were: (1) women, diagnosed with first ever ischemic stroke according to the definition and verified by CAT scan. Stroke was defined as focal neurological deficits of acute onset, lasting >24 hr, due to brain ischemia as shown by CAT scan or of presumed ischemic nature after appropriate clinical and neuroradiological workup [WHO, 1989]; (2) stroke symptoms in at least 1 month; (3) normal cognitive function (mini-mental state examination a.m. Folstein, score >25) [Folstein et al., 1976]; (4) UI according to the definition of ICS [Abrams et al., 1988, 1990], with start in close relation to the stroke; (5) independent walking abilities indoors >100 m with/without aids; (6) independence in toilet visits; (7) age between 40 and 85 years.

Exclusion criteria were: (1) urinary tract infection; (2) symptom of vaginal prolaps; (3) chronic respiratory diseases; (4) psychiatric diseases; (5) other neurological diseases; (6) do not speak Danish.

The subjects received written and verbal information and signed an informed consent. The ethical committee for The Copenhagen County had approved the study. The subjects were outpatients at the time of the study and were offered free transportation for examinations and intervention visits at the hospital.

The medical records of the subjects were screened and subjects were included in the study based on in- and exclusion criteria. The UI-status of the subjects was determined by interview and subjects not fulfilling to the UI inclusion criteria were excluded (Fig. 1).

Method

The design was an experimental, prospective, randomised and single-blinded, parallel group trial. All subjects had a 4 weeks run-in period with baseline registration and the first examination sequence (pre-test). After the run-in period the subjects were randomised either to a Treatment Group (TG) or to a Control Group (CG), by a randomised procedure using a mathematical table and sealed numbered envelopes. The randomisation was done by a physiotherapist without any further relation to the study prior to the inclusion of the subjects. The randomisation code remained blinded for the investigators until the last subject was examined. After 12 weeks a second examination sequence was performed (post-test). The subjects in CG were offered treatment after the study.

Measurements

The outcome was measured by three objective and functional tests:

1. A voiding diary in a Modified version [Wymann et al., 1988; Larsson et al., 1991] measuring the variables (primary outcome):
   a. Time and frequency of voiding.
   b. The number of incontinence episodes.
   c. The number of used pads.

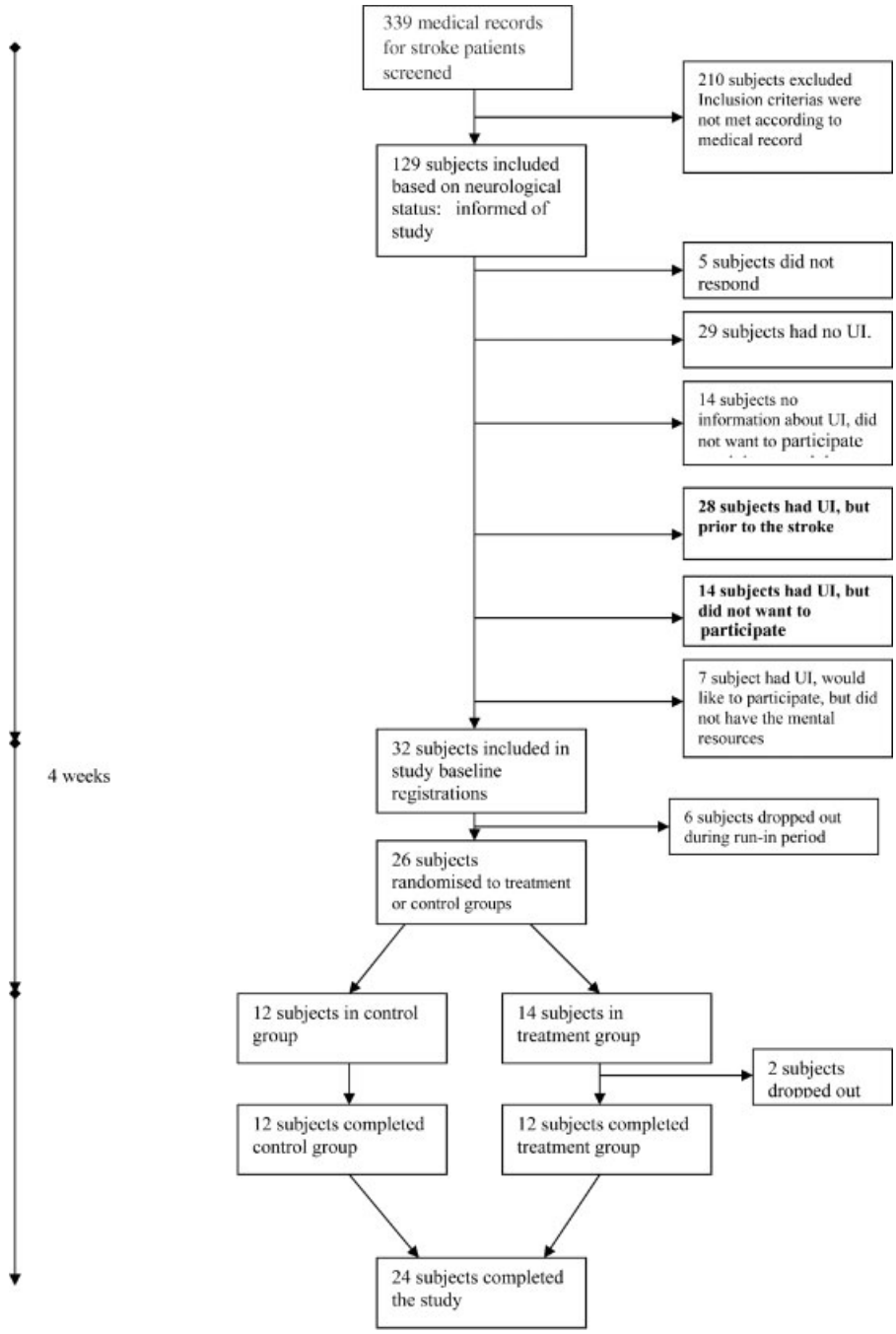

Fig. 1. Study profile.

The diary was self administered and the subjects did not have the first diary available when they completed the second one. All subjects were informed of the purpose of the diary and instructed how to fill in records continuously over a 3 days period. The detailed instructions were printed as part of the introduction to the diary. Daytime was defined as the time between 7.00 am and 23.00 pm and nighttime between 23.00 pm and 7.00 am.

2. A 24-hr home pad test (primary outcome).

A 24-hr home pad test was performed [Lose and Versi, 1992; Rasmussen et al., 1994] and the subjects were allowed to wear as many pads as they needed. Used pads were then enclosed in self-sealing plastic bag. Pad number and weight were recorded before and after use by the researcher.

The subjects were instructed not to change their daily activities and fluid intakes. The subjects personally returned the pads to the research centre.

3. Vaginal palpation of PFM. (Secondary outcome).

Vaginal palpation of PFM was performed measuring:

a. The function of the PFM [Thorp et al., 1991].

The result was expressed according to a specific, graduated, developed four-point, ordinal scale: no muscle contraction = 0; muscle contraction + hemi paralysis = 1; muscle contraction + co-contraction with other related muscles (e.g., glutei, hip adductors) = 2; isolated pelvic floor muscle contraction = 3.

b. The strength of PFM.

The result was expressed on a Danish version of the modified Oxford grading system [Brink et al., 1989; Laycock, 1992]. The subjects were instructed to perform a maximal voluntary contraction (MVC) at PFM without co-contraction of other related muscles. The test was performed three times and the best result was recorded.

c. The static endurance of PFM.

The static endurance of PFM was measured by stop watch and the result was expressed as the time in seconds to perform a PFM contraction. The subjects were instructed to keep the contraction of PMF at 30% of maximum contraction level as long time as possible. The cut-off time was 30 sec.

Static endurance was defined as the point of isometric fatigue where the muscle contraction can no longer be maintained at a certain level [Alaranta et al., 1994].

d. The dynamic endurance of PFM.

The dynamic endurance was determined by the number of PFM contractions. The subjects were instructed to repeat the contraction of PFE as frequently as possible, with a contraction of 6 sec and a relaxation of 6 sec at a 30% of maximum contraction level. The dynamic endurance was defined as the point when repetitive work no longer can be sustained at a certain force level [Alaranta et al., 1994].

Procedure of vaginal palpation: the instructions and test procedure were standardised in all four tests for all subjects by the physiotherapists. The evaluation of these tests was done by two experienced physiotherapists, who were blinded for the randomisation code and the result of the first test. At present no studies of inter- and intra reliability tests of the four vaginal test (Danish version) are published as the studies are still ongoing.

Intervention

The subjects in TG were treated in a systematic, controlled, intensive PFM programme during 12 consecutive weeks by the same specialised physiotherapist (ST). The procedure is presented in Table I.

TABLE I. Treatment Programme of Pelvic Floor Muscle Exercise in Women With Urinary Incontinence (UI) After Stroke

Introduction (theory)	1 hr
Group treatment	6–8 patients/group
Frequency	1 hr/week
Duration	12 weeks
Attendance in group treatment sessions	Min. 8 times
Vaginal palpation	2–3 times
Home exercises	1–2 times daily

The content of the treatment program:

1. Introduction: (a) group information about UI problems, duration and experiences; (b) definition of UI types; (c) anatomy and physiology of the bladder and the PFM; (d) instruction in self-palpation of PFM; (e) motivation and instruction in home exercises.
2. Home exercises: (a) strength PFM exercise by performing close to maximum contraction (6 sec contraction/6 sec rest) [Nygaard et al., 1996]; b) endurance PFM exercise by performing 30% of maximum contraction as long time as possible (max 30 sec contraction/30 sec rest). Patients were instructed to repeat the exercise programme gradually 6–10 times in supine, standing and sitting positions, 1–2 times daily.
3. Group treatment: (a) isolate PFM contraction (6 sec contraction/6 sec rest); (b) strength exercises (3 sec contraction/3 sec rest, and 6 sec contraction/6 sec rest); (c) endurance exercises (max 30 sec contractions/30 sec rest). All techniques wererepeated 4–8 times in supine, standing and sitting positions; (d) PFM contractions before and during daily activities as rising, sitting and walking; (e) vaginal palpation of PFM was performed to control correct contraction, and to give continually feed-back to the subjects and to evaluate the strength. The training programme is a Modified version of a standard training programme for group treatment of stress incontinence [Bø, 1990].

The subjects in CG followed the normal, standard programme of general rehabilitation without any specific treatment of UI.

Statistics

Statistical calculation was done by means of Statistical Package of Social Science (SPSS), version 10.1. Median and quartile ranges are presented. The null-hypothesis are tested by Mann–Whitney *U*-test between groups and by Wilcoxon test within groups. The level for statistical significance was accepted at $P < 0.05$.

RESULTS

Three hundred and thirty-nine medical records of women with stroke were screened (Fig. 1). According to the inclusion and exclusion criteria 129 subjects were invited to participate in the study [Tibaek et al., 2004] (Fig. 1), but 28 (23%) subjects had UI before the stroke, 14 (11%) subjects with UI did not want to participate, 7 (5%) subjects with UI wanted to participate but did not have the resources.

Twenty six subjects accepted the invitation and were randomised, 14 in TG and 12 in CG. Two subjects from TG dropped out after 1 and 2 weeks intervention respectively, during the treatment period, none from CG dropped out. The reasons for termination were abdominal diseases/surgery (n = 1) and social problems (n = 1). Thus, 24 subjects (92%) completed the PFMT, 12 in TG and 12 in CG. The median age for the remaining 24 subjects was 60 years. The attendance rate to treatment sessions was 90%.

Baseline characteristics of the subjects, who completed the trial, are presented in Table II and baseline, neurological characteristics in Table III. At baseline no differences between the TG and the CG were detected.

A few subjects did not complete all investigations leading to missing values in some parameters. Data were missing from 0% to 4% in investigators-administrated variables compared to 0%–21% in subject self-administrated variables. The reasons for missing data were: impaired cognitive and physical status (n = 1), influenza (n = 1), lack of mental resources (n = 2), unknown reason (n = 1).

The results of PFMT measured by the two quality of life questionnaires: SF-36 and IIQ have been published previously [Tibaek et al., 2004].

The Diary

The results of the diaries recorded over 2 and 3 days are presented in Table IV.

Frequency of voiding in daytime showed significant improvement in the TG recorded over 3 days ($P = 0.036$) and over 2 days ($P = 0.021$). Frequency of voiding, totally, recorded over 2 days decreased also significantly in TG ($P = 0.028$). In TG there was no difference within groups in frequency voiding in nighttime, number of incontinence episodes, and number of pads.

Frequency of voiding in daytime recorded over 3 days showed no significant differences between groups at pre-test ($P = 0.698$) but significant lower frequency compared to CG at post-test ($P = 0.018$). The remaining variables did not differ significantly between TG and CG.

The ability of the subjects to complete the self-administrated diary decreased with the length of recording period. The numbers completing the diaries were the following: 1 day: TG = 92%, CG = 100%; 2 days: TG = 92%, CG = 83%; 3 days; TG = 83%, CG = 67%.

The 24-hr Home Pad Test

The result of 24-hr home pad test is presented in Figure 2. A tendency to significant improvement in TG was noted ($P = 0.092$), whereas there was no change in CG ($P = 0.553$).

At pre-test there was no significant difference between groups whereas at post-test a significant difference was noted ($P = 0.013$). The results in TG showed reduced urine loss from 8 (medium value) to 2 g/24 hr, a decrease of 75%. In CG the urine loss reduced from 12 (median value) to 8 g/24 hr giving a decrease of 33%.

Vaginal Palpation of PFM

The results of vaginal palpation of PFM are presented in Figure 3 and Table V.

One subject was not able to perform PFM function at pre-test, and all subjects performed PFM function at the post-test. One subject had hemi-paralysis of PFM at pre-test,

TABLE II. Baseline Characteristics of Stroke Patients With UI

Characteristics	Treatment Group (n = 12)	Control Group (n = 12)	*P*
Age, years	59 (56–72)	62 (52–75)	0.799
Childbirth, number	2 (1–3)	2 (2–3)	0.713
Gynaecological surgery:			
None	7 (58%)	5 (42%)	–
One or more	5 (42%)	7 (58%)	–
Urinary incontinence type:			
Stress	1 (8%)	2 (17%)	–
Urge	5 (42%)	3 (25%)	–
Mixed	6 (50%)	7 (58%)	–
Mobility:			
Walking distance, m	1,000 (500-5,000)	3,500 (400-5,750)	0.688
Cycling distance, km	0 (0–4)	0 (0–9.5)	0.353
Walking stairs, amount of steps	60 (20–100)	40 (23–90)	0.733
Sport/exercises, minutes per week	0 (0–30)	68 (0–113)	0.65

Median values (quartile range) and number (%) are presented.

TABLE III. Baseline, Neurological Characteristics of Stroke Patients With UI

Neurological characteristics	Treatment Group (n = 12)	Control Group (n = 12)	*P*
Since stroke, months	12 (2–20)	13 (2–50)	ns
Size of ischemic infact on CAT scan:			
Small	2 (17%)	4 (33%)	ns
Moderate	0 (0%)	0 (0%)	ns
Large	1 (8%)	1 (8%)	ns
No information	9 (75%)	7 (58%)	ns
Localisation:			
Left, hemisphere	3 (25%)	7 (58%)	ns
Right, hemisphere	6 (50%)	4 (33%)	ns
Bilat	2 (17%)	1 (8%)	ns
No information	1 (8%)	0 (0%)	ns
Mini-mental state examination (maximum score = 30)	30 (29–30)	30 (29–30)	ns

Median values (quartile range) and number (%) are presented.

whereas none had it at post-test. Four subjects could correctly perform isolated PFM contraction at pre-test (TG = 1; CG = 3), whereas eight subjects were able to do this at post-test (TG = 6; CG = 2). The correct, isolated function in TG was 1/11 (9%) at pre-test and improved to 6/11(55%) at post-test.

Likewise was the correct isolated function in CG 3/12 (25%) and decreased to 2/12 (16.5%).

In the TG significant improvements were demonstrated with respect to function ($P = 0.034$), strength ($P = 0.046$), static endurance ($P = 0.028$) and dynamic endurance ($P = 0.020$) when pre-test were compared to post-test.

In CG only strength ($P = 0.034$) had improved significantly so, whereas there were no significant differences at function ($P = 1.000$), static endurance ($P = 0.116$) or dynamic endurance ($P = 0.223$).

At pre-test there were no differences between groups whereas at post-test significant differences were found in dynamic endurance ($P = 0{,}028$). No significant changes were noted in function ($P = 0.062$), in strength ($P = 0.799$) and in static endurance ($P = 0.278$) (Table V).

DISCUSSION

To our knowledge the present study is the first investigation of effects of PFMT in a random sample of women with UI after stroke. Equally to our knowledge the present study is the first study using voiding diary recordings, pad test and vaginal palpation as measurements for women with UI after stroke.

Voiding Diary

The results of the diary recordings showed that PFMT was highly effective, the frequency of voiding in daytime was reduced and the total voiding frequency decreased significantly. In healthy women the frequency of voiding in daytime per is 5–6 [Burgio et al., 1991] which is just the result we found in TG after PFMT.

No guidelines have been found indicating the minimum number of diary-recording days to receive reliable data. The Standardisation Committee of International Continence Society (ICS) recommended voiding diary (frequency/volume chart) kept for at least 24 hr [Abrams et al., 2002].

TABLE IV. Results of Voiding Diary Recorded Over 2 and 3 Days Period in Women With UI After Stroke

	2 days (TG: n = 11 CG: n = 10)			3 days (TG: n = 10 CG: n = 8)		
Recording period	Pre-test	Post-test	*P*	Pre-test	Post-test	*P*
Voiding frequency totally/24 hr						
TG	10 (8–12)	8 (7–9)	0.028*	9 (8–13)	7 (7–9)	0.107
CG	9 (8–13)	8 (7–12)	0.171	9 (8–12)	9 (7–13)	0.753
Voiding frequency, daytime/24 hr						
TG	7 (6–11)	5 (5–7)	0.021*	7 (5–11)	6 (5–7)	0.036*
CG	8 (7–10)	6 (5–10)	0.074	8 (6–10)	9 (7–13)	0.888
Voiding frequency, nighttime/24 hr						
TG	2 (1–3)	1 (1–2)	0.234	1 (1–3)	2 (1–2)	0.733
CG	1 (1–2)	1 (1–3)	0.348	2 (1–2)	2 (1–3)	0.605
Number of incontinence episodes/24 hr						
TG	0 (0–2)	0 (0–0)	0.518	0 (0–1)	0 (0–0)	0.680
CG	0 (0–2)	0 (0–1)	0.102	1 (0–3)	0 (0–1)	0.285
Number of used pads/24 hr						
TG	0 (0–2)	1 (0–2)	0.176	1 (0–1)	1 (0–1)	0.10
CG	2 (0–5)	1 (0–4)	0.573	1 (1–5)	1 (0–3)	0.674

*Significance at $P < 0.05$.
Median, quartile range are presented.
TG, indicate Treatment Group; CG, indicate Control Group.

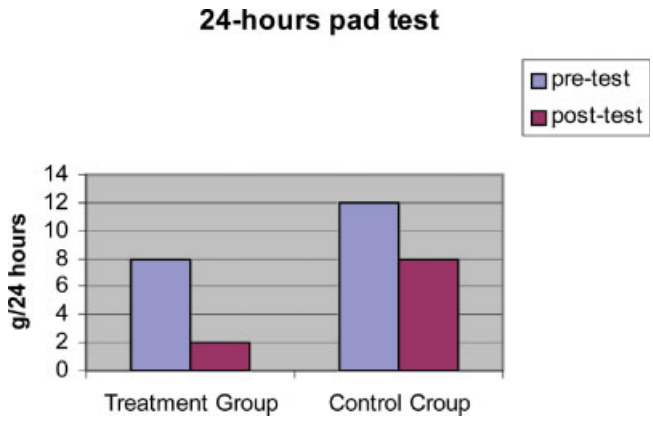

Fig. 2. Result of 24-hr pad test. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

We motivated the patients to complete the diary in 3 days, but found that the sample size decreased remarkable from 1 to 3 days recording. Larsson et al. [1991] evaluated the reproducibility of two 24-hr voiding diaries in non-neurological patients and found limited concordance with the frequency of voiding. Nygaard and Holcomb [2000] evaluated a 7 days diary in women with stress incontinence and the correlation between the results of the first 3 days of a diary and the results of the last 4 days was high, suggesting that a 3 days diary is an acceptable outcome measure for clinical trials evaluating treatment for stress incontinence. Groutz et al. [2000] found that a 24 hr micturition diary and a pad test were reliable instruments in 109 non neurological patients with UI assessing degree of urine leakage and number of incontinence episodes. Increasing test duration to 48 and 72 hr increased reliability but decreased compliance.

Reproducibility of diary recordings in women with UI after stroke has never been studied and it can be estimated that they may have even lower compliance due to their neurological deficits.

In addition, we did not use a diary measuring fluid intake and voiding volume as parameters, although these variables may have given important information. On the other hand such detailed diaries may also have complicated the study unnecessarily.

Pad Test

We found a significant effect of PFMT measured by 24-hr pad test between groups although the sample was small. It is surprising that we found a positive test in CG also ($\geq$4 g/24 hr) [Blaivas et al., 1997]. One explanation to that can be the lack of fluid intake/volume chart. Another explanation could be that the activity level of the post-test period was changed in relation to the pre-test periods.

Previous studies of UI at stroke patients have reported the urine leakage by a subscale in Barthel Index [Nakayama et al., 1997; Kolominski-Rabas et al., 2003] or Functional Independence Measure [Wikander et al., 1998]. No objective quantification has been published earlier.

The 24-hr pad test was completed by 83% of the sample. In a larger study of 194 females with lower urinary tract symptoms Versi et al. [1996] found similar results as 161 (83%) completed perfectly a 48 hr pad test. In this perspective we therefore suggest, that a pad test is used as an outcome measurement in future clinical trials of stroke patients and other specific disease group.

Vaginal Palpation

Positive effects of PFMT were indicated in all four tests using vaginal palpation.

PFM function was found in all subjects at post-test, and the isolated PFM contraction was improved in TG, though not all subjects were able to do it correctly. Kegel [1956] pointed out that women with stress UI have incorrect PFM

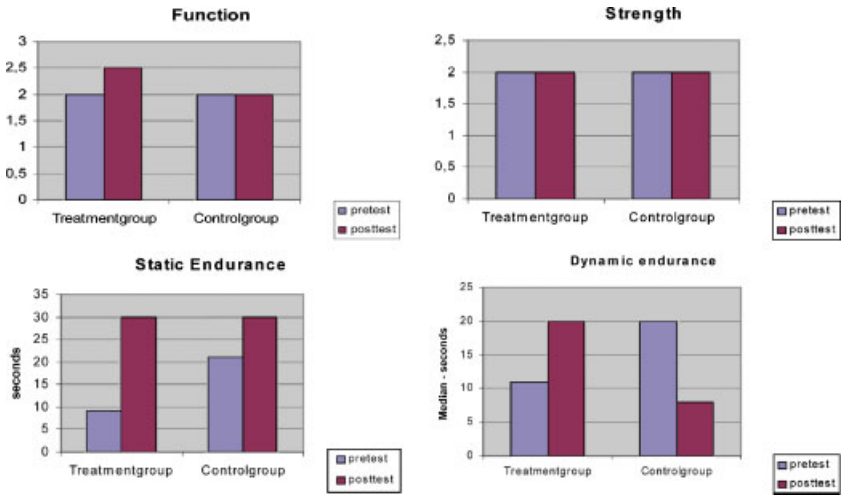

Fig. 3. Results of vaginal palpation. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

TABLE V. Results of Vaginal Palpation of Pelvic Floor Muscle in Women With UI After Stroke

TG = Treatment group, n = 11; CG = Control group, n = 12	Pre-test	Post-test	*P*
The function of the pelvic floor muscle			
TG	2 (2–2)	2 (2–3)	0.034*
CG	2 (2–3)	2 (2–2)	1.000
The strength of the pelvic floor muscle			
TG	2 (2–3)	2 (2–3)	0.046*
CG	2 (0–4)	2 (1–5)	0.034*
The static endurance of the pelvic floor muscle			
TG	9 (3–30)	30 (14–30)	0.028*
CG	21 (0–30)	30 (7–30)	0.116
The dynamic endurance of the pelvic floor muscle			
TG	11 (0–7)	20 (11–20)	0.020*
CG	20 (0–20)	8 (1–20)	0.223

Median, quartile range are presented.
*Significance at $P < 0.05$.

contraction. In 47 women with stress UI more than 30% were unable to contract their PFM properly despite adequate information according to Bø et al. [1988].

We included the vaginal palpation in four specific adjusted tests as measurement in the present study because experiences from working with ordinary stress UI patients showed it to be a useful tool although it is a weakness of to the study, that validation and reliability is needed in neurological patients. The Standardisation Committee of ICS did not recommend vaginal palpation as a sensitive outcome measure in research [Shull et al., 2002]. Mattiasson [2001] found vaginal palpation to be a simple and relevant method which gave adequate information about the structure and function comparable with electromyography (EMG) and perinometry in woman with stress UI. Gunnarsson and Mattiasson [1999] found a high correlation between the results of PFM function estimated by EMG compared to PFM function as estimated by vaginal palpation in a group of incontinence women and likewise for a group of continent women. Therefore EMG and perinometry may be useful complementary tests of PFM in future research.

PFM strength in TC improved significantly after PFMT, and we found significant improvement, although to a lesser degree in CG too, which indeed is surprising. Why did PFM strength improve in CG? One explanation could be awareness and the learning effect at PFM during the pre-test. However, the improvement of strength in CG did not parallel the effect on urine loss at pad test or frequency of voiding in daytime and there is still a marked additional effect of the applied treatment programme. Another explanation could be more theoretical. In non neurological studies of women with stress UI and mixed UI the theoretical thesis behind PFMT effect is based on improvement of PFM strength. The question is what is the mechanism explaining the effect of PFMT in women with UI after stroke? Is it motor learning mechanism and the increased cerebral control and brain plasticity, which improve after a unspecific rehabilitation programme. Or is it the other components of the PFM such as static and dynamic endurance, or a combination of PFM improvement?

We chose the Modified Oxford Scale measuring strength because it was the most simple, low cost and in clinical practice most used assessment tools, although there was a disadvantage of individual subjective observer.

Objective measurements such as surface EMG [Gunnarsson and Mattiasson, 1994] and perinometry [Hahn et al., 1996] have been developed as useful objective instruments measuring strength in women with UI. One weakness of these approaches was that recording from an intra-vaginal surface EMG do not ensure absence of cross-talk coming from the electrical activity of other skeletal musculature [Fowler et al., 2002]. Pressure measurements also provide an indirect indicator of muscle strength. Any contraction in the abdominal muscle may influence the pressure reading [Hahn et al., 1996; Peschers et al., 2001].

Dumoulin et al. [2003] had developed a new, promising and reliable dynamometer for measuring PFM strength, but it has not yet been tested in any clinical trial and is only developed for women with stress UI.

These tests can perhaps be important complimentary tests in future research of PFM strength.

The Danish version of the modified Oxford grading system has so far not been tested for validity and reliability in neurological women with UI.

In static endurance we found a very positive effect of PFMT within groups. The effect improvement could perhaps have been larger, but the standard cut-off was determined to 30 sec.

The tests of static and dynamic endurance were specified, adjusted from subscales in the "P.E.R.F.E.C.T" assessment scheme [Laycock, 1994] and are not yet tested for validity or reliability in neurological women with UI.

We choose to evaluate the static endurance of PFM, because the rationale behind PFMT in non neurological women with urge UI is that PFM contraction inhibits detrusor muscle contraction [Bø and Berghams, 2000]. Therefore, we wanted to evaluate how long the subjects could maintain a PFM contraction. The purpose of the present study was not to test that hypothesis, but to evaluate different components of PFM. In dynamic endurance we found a positive effect of PFMT measured both within groups and between groups.

We choose to evaluate a standard dynamic endurance test because the number of PFM contractions according the definition of dynamics endurance, is a sign of fatigue level of the muscle.

Finally the limitation of this study was the small number of patients and the need of highly reliable, sensitive outcome measurements. Similar studies with larger samples and reliable instruments are recommended.

CONCLUSION

The results indicated a positive effect of PFMT in women with UI after stroke such as reduced frequencies of voiding and urine leakage, and improved pelvic floor muscle function, strength, static and dynamic endurance. Although the underlying mechanism is unclear, it was possible to study the effects in a controlled, randomised and blinded design and the results are promising.

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