Paratonia enlightened

definition, diagnosis, course, riskfactors, and treatment

Hans Hobbelen

Paratonia enlightened

definition, diagnosis, course, riskfactors, and treatment

Hans Hobbelen

The research described in this thesis was performed in the Care and Public Health Research Institute (Caphri) and the School of Mental Health and Neuroscience (MHeNS) of the Maastricht University Medical Center, and the Alzheimer Center Nijmegen (CAN), which is part of de Nijmegen Center for Evidence Based Practice (NCEBP) of the Radboud University Nijmegen, Medical Centre.

Financial support to perform this research project was provided by the Vitalis WoonZorg Groep Eindhoven.

The publication of this thesis was kindly financed by Quattron techniek BV, Ridderkerk, Wetenschappelijk College Fysiotherapie (WCF), Stichting steunfonds Faculteit Gezondheidszorg Hogeschool Utrecht, Nederlandse Vereniging voor Fysiotherapie in de Geriatrie (NVFG) and Nederlands Paramedisch Instituut, Amersfoort (Dutch Institute of Allied Health Care, NPi).

Coverdesign: Mientje Meussen en Hans Hobbelen

ISBN: 978-94-6108-095-0

Layout and printed by: Gildeprint Drukkerijen - Enschede, the Netherlands

Paratonia enlightened

definition, diagnosis, course, riskfactors, and treatment

PROEFSCHRIFT

ter verkrijging van de graad van doctor aan de Universiteit Maastricht,
op gezag van de Rector Magnificus, Prof mr. G.P.M.F. Mols
volgens het besluit van het College van Decanen,
in het openbaar te verdedigen
op dinsdag 14 december 2010 om 16.00 uur

door

Johannes Simon Maria Hobbelen

Promotores:
Prof. dr. R.A. de Bie
Prof. dr. F.R.J. Verhey
Prof. dr. R.T.C.M. Koopmans (St. Radboud Universiteit Nijmegen)

Beoordelingscommissie:
Prof. dr. J. Schols (voorzitter)
Prof. dr. P.N. van Harten
Prof. dr. K. Horstman
Dr. T. van Laar (UMC Groningen)
Prof. dr. E. Scherder (Vrije Universiteit Amsterdam)

Contents

Chapter 1:	General introduction.	9
Chapter 2:	Effect of passive movement on the severity of paratonia: a partially blinded, randomized clinical trial.	19
Chapter 3:	Paratonia: a Delphi procedure for consensus definition.	33
Chapter 4:	Diagnosing paratonia in the demented elderly: reliability and validity of the Paratonia Assessment Instrument (PAI).	45
Chapter 5:	Prevalence, incidence and risk factors of paratonia in patients with dementia; a 1-year follow-up study.	61
Chapter 6:	Passive movement therapy in patients with moderate to severe paratonia; study protocol of a randomised clinical trial (ISRCTN43069940).	77
Chapter 7:	Passive movement therapy in severe paratonia; A multi-centre randomized clinical trial.	89
Chapter 8:	General Discussion.	105
	Summary	115
	Samenvatting	121
	Dankwoord	129
	About the author	135
	List of publications	139

1

General introduction

Author:
Hans Hobbelen

Introduction

In the years after the diagnosis of dementia, patients do not only show a cognitive decline but also a progressive decline in their movement abilities. This is a gradual decline over years in which first intentional movements become unstructured and clumsy, second walking abilities decline by slowing down and finally the patient becomes wheelchair bound or even bedridden with a very high muscle tone and no capabilities to communicate.[1] The muscle tone can increase severely and can even result in a characteristic bed posture with flexed arms and legs and the head floating above the pillow. [2] This phenomenon appears to be indifferent of the type of dementia. In the latter stages patients become more and more dependent on professional carers. The development of this high muscle tone, often referred to as paratonia, is noted to be of importance in the decline of the quality of life and results in an exponential increase of the carer's burden in the final stages of the disease.
This thesis reflects the search for a better understanding of the phenomenon of paratonia. Passive Movement Therapy is one of the most frequently used interventions by physiotherapists in Dutch nursing homes to reduce the high muscle tone and sustain the range of motion. General doubt about the efficacy of this treatment was the reason to increase the insight into Paratonia.

Paratonia

"La paratonie; imposibilité de la resolution volontaire des muscles", that is "Paratonia; the impossibility to voluntarily relax the muscles", was first mentioned in a paper by the French physicians Dupré and Gelma in 1910. They observed that motor impairments can be associated with mental impairment. [3] In 1927 the German physician and scientist Kleist observed in patients with dementia a phenomenon of very high muscle tone, which reacted against speeding up the movement during physical examination. He called the high muscle tone "Gegenhalten" ("hold against" or "resistance") and the reaction against speeding up the movement "hervorgelocktes Gegenhalten" ("provoked resistance").[4]
See figure 1

Figure 1. Example of "hervorgelocktes gegenhalten" ("provoked resistance") by Kleist in 1927.[4]

In the Netherlands, in the mid-1980s, interest grew in this phenomenon probably due to the development of an abundance of well-equipped, multidisciplinary-staffed nursing homes for the treatment of patients with complex health problems. In these nursing homes it became apparent that in the late stages of the dementia a typical hypertonia occurred which obstructed normal care for these patients. Middelveld-Jacobs and Van den Boogerd characterized this hypertonia as distinctive different from spastic hypertonia and Parkinsonian rigidity.[2] Through their publication they introduced the term paratonia in the Netherlands.

Prevalence estimates of paratonia in dementia vary considerable. Most studies suggest that paratonia increase with an increasing severity of the dementia. Souren et al. found a prevalence of paratonia of 10% in the early stages of dementia and 90% in the late stage of dementia.[1]
Paratonia appears to be not exclusively related to Alzheimer's disease. Benassi et al. and Gladstone et al. report a prevalence of approximate 1% in normal healthy elderly.[5, 6] In a cross-sectional study with 55 Alzheimer's Disease patients and 55 controls pair-matched for age, sex and location, O'Keeffe et al. found a prevalence of paratonia of 2% in the control group.[7] A prevalence of paratonia was found in Multi-infarct dementia and Depression of respectively 62% (n=7) and 44% (n=5).[8]

Searches in MEDLINE, EMBASE, CINAHL, PEDro and PsychINFO resulted in a description or definition of paratonia in 16 papers.[1-4, 6, 8-18] These descriptions varied from a very simple "active resistance against passive movement" to more extensive definitions. Most authors agree on that it is distinctively different from parkinsonian rigidity and spasticity, yet most are not specific in what way. Moreover, there is uncertainty about some elements like the presence of cogwheeling (ratchety catch of the limb when moved) or the possible exacerbation of paratonia by sound/light and the verbal command to relax.
Beversdorf and Heilman reported that in the early stages of dementia Mitgehen, or actively assisting the passive movement due to an inability to relax, as a first sign of paratonia. They called this phenomenon facilitory paratonia which they believe develops gradually in Gegenhalten or oppositional paratonia, an irregular resistance to passive movement.[9]

Little is known about the development of paratonia. Central cerebral pathology is hypothesized in literature.[1, 4, 7, 9-13, 18]. Paratonia has been linked with substantia nigra pathology and dysfunction of the frontal lobes.[1, 6, 7, 9-11, 14, 15, 17-19]

The variety in descriptions indicates that there is obviously no consensus on certain elements of the description of paratonia. The wide variety of the prevalence of paratonia in all different kinds of dementia populations can also be a sign that the description of paratonia is not yet discriminative enough. This problem has been recognised in movement disorders in

dementia in general by Kurlan et al.[13] Their paper, an invitation for more rigidity in definitions of movement disorders in dementia, has been a further stimulus to elucidate paratonia.

Assessment tools for paratonia

It is no surprise that due to the lack of a good, valid international description, no valid or reliable assessment tool for diagnosing paratonia exists in literature.

For the severity of paratonia, however, a modification of the Ashworth scale has been developed in the Netherlands and has proved to be valid and reliable.[20] This is a 5-point Modified Ashworth scale in which 0 = no resistance to passive movement, 1= slight resistance during passive movement, 2= more marked resistance to passive movement, 3 = considerable resistance to passive movement, 4= severe resistance, passive movement is impossible.

Interventions

Along with the increasing interest and the awareness of the impact of paratonia on the quality of life in late stage dementia, several interventions have been developed. Most of these interventions are, however, practice-based and not well described. Interventions for paratonia in early stage dementia are not known. Furthermore, it is surprising that international descriptions of interventions for paratonia are practically nonexistent.

The three main interventions are all non-medical and mostly performed by physiotherapists, occupational therapists, or nurses. These three interventions are 1) the concept of Passivity in Daily Life (PDL), 2) positioning programs or good stabilizing cushions and 3) Passive Movement Therapy (PMT).

PDL

Central in the viewpoint of this concept, developed by physiotherapists and occupational therapists, is the acceptance of the high muscle tone and immobility.[21] No action is undertaken to improve the mobility or to reduce the muscle tone. All interaction of carers with patients is carefully analysed and described step-by-step in the most comfortable way for both. A thorough instruction in all these steps and an intensive rehearsing period is necessary for all personnel involved.

Good stabilizing cushions

Positioning programs or good stabilizing cushions are nowadays widely used to support the bed and wheelchair position of late stage dementia patients. There are several reasons for doing this. First, obvious support to achieve a comfortable position of the patient, and second, firm well-fitting support is believed to be effective in decreasing the muscle tone. Van de Rakt, who claims that the high muscle tone results from dementia patients losing their contact with the outside world, has described the latter one. In his view improving the tactile information could enhance this by which the muscle tone should decrease.[22]

Passive Movement Therapy

Passive movement therapy (PMT) is a therapeutic intervention designed to increase the passive extensibility of muscles, ligaments and collagen in order to achieve maximal joint range of motion [23, 24]. A recent NIVEL report revealed that PMT is one of the main physiotherapeutic interventions in Dutch nursing homes, being used in 28.2% of all treatments. The average duration of PMT is 30 minutes per patient per week [25]. This therapy is generally believed to be effective in patients with paratonia and is also used as a maintenance therapy to prevent or treat contracture formation [26, 27]. Although these patients often indicate discomfort during PMT, health care professionals claim that this therapy, if given shortly before washing and bathing, reduces pain and facilitates caring for the patients due to improved range of motion of affected limbs.

The rationale for this therapy is based on investigations in other populations, e.g., patients with spasticity and contractures in which the results show a temporary effect, or a so-called elastic deformation, due to the visco-elastic properties in all tissues [23]. After 20 to 30 minutes, joint range of motion returns to the starting values. These investigations indicate that a permanent effect, or plastic deformation, is only possible if the patient can actively use the gained mobility [23, 24]. The fact that patients with paratonia are often not able to actively use regained mobility makes the use of PMT controversial. Moreover, because animal studies indicate that when activated muscles fibres are stretched, which is the case with PMT in paratonia, older tissues are more susceptible to injury on sarcomere level[28]. In this way the signs of discomfort during PMT, often not well understood by clinicians, gain in significance. Nonetheless, maybe because of a lack of alternatives, or because of pressure of concerned relatives, physicians and physiotherapists start PMT.

Evidence-based practice

Scientific evidence, patient's circumstances, the patient's preferences and the clinical expertise to integrate the previous components are the four pillars of Evidence-Based Practice (EBP) proclaimed by Haynes and derived from the original ideas of Guyatt et al. [29] See figure 2.

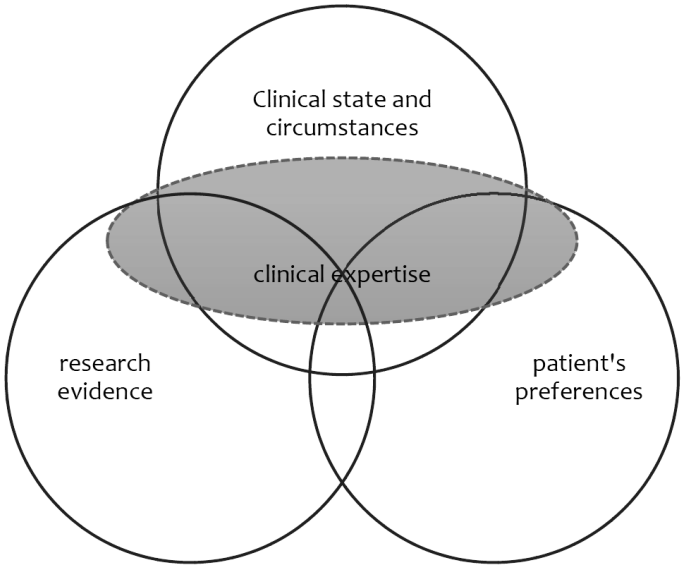

Figure 2. Model of the four pillars of evidence-based practice according to Haynes. [29]

In both physiotherapy and in old-age psychiatry, EBP has been recognized as the standard of improving the quality and effectiveness of care provided by practitioners.[30, 31] The challenge of implementing EBP in daily psycho-geriatric care is complicated. To limit confounding and bias, most scientific research is designed with a strict control on all influencing factors by which variation in the treatment population is not tolerated. Extrapolation of research results is therefore difficult in the field of psycho-geriatrics, in which a heterogeneous population is rather the rule than the exception. A promising development for the future are the upcoming pragmatic controlled clinical trials, in which research is conducted in the actual clinical practice with patients who represent the full spectrum of the population in which the treatment might be applied.[32] Another challenge is the third pillar of Haynes model, the patient's preferences. With patients having varying levels of cognitive impairment, it appears to be difficult for the clinician to evaluate the decisional capacity and the ability to engage the patient in an informed process of weighing the value of different treatments. In this way the patient's preferences appear to be more or less dependent on the clinician's expertise, thus in this instance imbalancing the model.

Aims of this thesis

The main objective of this thesis is to search for a better understanding of the phenomenon of paratonia and the improvement of daily care of those who suffer from it.

For this we formulated four aims: (1) to realize a valid description of paratonia, (2) to give the clinician a tool for diagnosing paratonia by which differentiation with other muscle tone disorders can be established, (3) to point out factors that influence the development and severity of paratonia, (4) to answer the question whether PMT has any beneficial effect on the severity of paratonia in late stage dementia patients.

Outline of this thesis

The pilot study entitled "The effect of Passive Movement Therapy (PMT) on the severity of paratonia: A partially blinded randomised clinical trial (pilot study)" is presented in **chapter 2**. The surprising result of this study was an important stimulus for further research.

To be assured of a more homogeneous study population in a new trial with sufficient power, our research group initiated a Delphi procedure with known experts in the field to achieve a new consensus definition of paratonia. This procedure and the results are presented in **chapter 3**. After four Delphi-rounds a new international consensus definition was established.

The possibility of an instant diagnosis of paratonia, even in the early stages of dementia, is important in daily practice for an accurate treatment strategy and to prevent the adverse effects of declining mobility like the development of contractures or pressure ulcers. Therefore we used this new definition as a basis for the development of the Paratonia Assessment Instrument (PAI) **(Chapter 4).**

To gain insight into the occurrence and the development of paratonia in early stage dementia, we designed a 1-year follow-up multi-centre longitudinal study. In this study, with the PAI as our primary outcome measure, we approached dementia day-care centres of nursing homes and residential homes with dementia special units (DCU's) in the region of Eindhoven, Helmond and Tilburg in the Netherlands for inclusion of reasonably fit and mobile dementia patients. **Chapter 5** presents the results of this study.
Finally we designed a randomized clinical trial in order to answer our initial research question: "is passive movement therapy an effective intervention on the severity of paratonia in comparison with usual care without passive movement therapy? ".
The study protocol is presented in **chapter 6** and the results of the RCT are presented in **chapter 7.**
Finally this thesis is concluded with a general discussion in **Chapter 8**.

References

1. Souren LE, Franssen EH, Reisberg B. **Neuromotor changes in Alzheimer's disease: implications for patient care.** J Geriatr Psychiatry Neurol. 1997;10: 93-98.
2. Middelveld-Jacobs I, Van den Boogerd M. **Paratonia, a form of hypertonia in a nursing home population.** Nederlands Tijdschrift voor Fysiotherapie. 1986;96: 85-87.
3. Dupré E. **Débilité mentale et débilité motrice associées.** Rev Neurol. 1910;20: 54-56.
4. Kleist K. **Gegenhalten (motorischer negativismus) zwangsgreifen und thalamus opticus.** Monatchr Psychiat Neurol. 1927;65: 317-396.
5. Benassi G, D'Alessandro R, Gallassi R, Morreale A, Lugaresi E. **Neurological examination in subjects over 65 years: an epidemiological survey.** Neuroepidemiology. 1990;9: 27-38.
6. Gladstone DJ, Black SE. **The Neurological Examination in Aging, Dementia and Cerebrovascular Disease. part 2: Motor Examination.** geriatrics and ageing. 2002;5: 44-49.
7. O'Keeffe ST, Kazeem H, Philpott RM, Playfer JR, Gosney M, Lye M. **Gait disturbance in Alzheimer's disease: a clinical study.** Age Ageing. 1996;25: 313-316.
8. Tweedy J, Reding M, Garcia C, Schulman P, Deutsch G, Antin S. **Significance of cortical disinhibition signs.** Neurology. 1982;32: 169-173.
9. Beversdorf DQ, Heilman KM. **Facilitory paratonia and frontal lobe functioning.** Neurology. 1998;51: 968-971.
10. Chatterjee A. **Feeling frontal dysfunction: facilitory paratonia and the regulation of motor behavior.** Neurology. 1998;51: 937-939.
11. Franssen EH, Kluger A, Torossian CL, Reisberg B. **The neurologic syndrome of severe Alzheimer's disease. Relationship to functional decline.** Arch Neurol. 1993;50: 1029-1039.
12. Joseph R. **Frontal lobe psychopathology: mania, depression, confabulation, catatonia, perseveration, obsessive compulsions, and schizophrenia.** Psychiatry. 1999;62: 138-172.
13. Kurlan R, Richard IH, Papka M, Marshall F. **Movement disorders in Alzheimer's disease: more rigidity of definitions is needed.** Mov Disord. 2000;15: 24-29.
14. Paulson G, Gottlieb G. **Development reflexes: the reappearance of foetal and neonatal reflexes in aged patients.** Brain. 1968;91: 37-52.
15. Risse SC, Lampe TH, Bird TD, et al. **Myoclonus, seizures, and paratonia in Alzheimer disease.** Alzheimer Dis Assoc Disord. 1990;4: 217-225.
16. Sweet RA, Akil M, Mulsant BH, Ulrich R, Pasternak RE, Zubenko GS. **Determinants of spontaneous extrapyramidal symptoms in elderly psychiatric inpatients diagnosed with Alzheimer's disease, major depressive disorder, or psychotic disorders.** J Neuropsychiatry Clin Neurosci. 1998;10: 68-77.
17. Tyrrell P, Rossor M. **The association of gegenhalten in the upper limbs with dyspraxia.** J Neurol Neurosurg Psychiatry. 1988;51: 995-997.
18. Tyrrell PJ, Sawle GV, Ibanez V, et al. **Clinical and positron emission tomographic studies in the 'extrapyramidal syndrome' of dementia of the Alzheimer type.** Arch Neurol. 1990;47: 1318-1323.
19. Bennett HP, Corbett AJ, Gaden S, Grayson DA, Kril JJ, Broe GA. **Subcortical vascular disease and functional decline: a 6-year predictor study.** J Am Geriatr Soc. 2002;50: 1969-1977.

20. Waardenburg H, Elvers W, Van Vechgel F, Oostendorp R. **Can paratonia be measured reliably? Evaluation of the reliability of a visual analogue scale and the modified tonus scale of Ashworth for measuring paratonia.** Nederlands Tijdschrift voor Fysiotherapie. 1999;102: 30-35.

21. van Eijle J. **Werkboek PDL.** Middelharnis: Mobicare, 1991.

22. Van de Rakt J. **The development of a fetal posisition in psychogeriatric patients; a hypothesis.** Fysiotherapie en ouderenzorg. 1997: 2-6.

23. Gajdosik RL. **Passive extensibility of skeletal muscle: review of the literature with clinical implications.** Clin Biomech (Bristol, Avon). 2001;16: 87-101.

24. Van Wingerden BAM. **mobilization.** Connective tissue in rehabilitation: Scripro Verlag Schaan Liechtenstein, 1997, pp. 197-241.

25. Leemrijse C, de Boer M, Ribbe M. **Paramedic care in Dutch nursing homes; explaining the differences?** Utrecht: NIVEL, 2005.

26. Arnts W, Van Oostwaard P, Rooyakkers A. **physiotherapy treatment for paratonia.** Nederlands Tijdschrift voor Fysiotherapie. 1989;99: 216-220.

27. Pomeroy V. **Immobility and severe dementia: when is phyiotherapy treatment appropriate.** Clinical Rehabilitation. 1994;8: 226-232.

28. Brooks SV, Faulkner JA. **The magnitude of the initial injury induced by stretches of maximally activated muscle fibres of mice and rats increases in old age.** J Physiol. 1996;497 (Pt 2): 573-580.

29. Haynes RB. **What kind of evidence is it that Evidence-Based Medicine advocates want health care providers and consumers to pay attention to?** BMC Health Serv Res. 2002;2: 3.

30. Evidenced Based Practice-An international Perspective. **Report of an Expert Meeting of WCPT Member Organisations.** WCPT, 2001.

31. Bartels SJ, Drake RE. **Evidence-based geriatric psychiatry: an overview.** Psychiatr Clin North Am. 2005;28: 763-784, vii.

32. Godwin M, Ruhland L, Casson I, et al. **Pragmatic controlled clinical trials in primary care: the struggle between external and internal validity.** BMC Med Res Methodol. 2003;3: 28.

2

The effect of Passive Movement Therapy (PMT) on the severity of paratonia: A partially blinded randomised clinical trial (pilot study)

Authors:
Hans Hobbelen
Rob de Bie
Erik van Rossum

Published in: Nederlands Tijdschrift voor Fysiotherapie 2003;113:132-137
(in Dutch, for this thesis translated into English)

Abstract

Introduction

Oppositional paratonia is a form of hypertonia in late-stage dementia. Grooming and dressing patients with oppositional paratonia is a problem for carers and nurses; passive movement therapy (PMT) is the main physiotherapeutic intervention. The aim of this study is to determine whether PMT is beneficial for these patients.

Methods

This randomised clinical trial involved residents of the De Weerde nursing home in Eindhoven, the Netherlands. Participants were randomised over three groups: group 1 received three sessions of PMT per week, group 2 used supporting cushions, and group 3 acted as a control group. Nine treatment sessions were given, and subjects were evaluated before and after each session using a modified Ashworth scale for paratonia. All four limbs were assessed in four movement directions (flexion, extension, abduction, and adduction).

Results

Fifteen patients from the psychogeriatric department of the De Weerde nursing home were included after screening and proxy consent. The only statistically significant difference between the three groups was for improved extension of the left leg after three weeks in the control group ($p = 0.016$). Trend analyses showed that PMT appears to be beneficial after one treatment, which supports carers' claims of a positive effect. However, the long-term effects of PMT are questionable. Supporting cushions were most beneficial for both arms after three weeks of treatment, and for flexion of both legs after one treatment session, but were clearly not beneficial for extension of both legs, especially after three weeks.

Conclusion

A trend analysis indicates that physiotherapeutic interventions can be effective, although PMT has no positive long-term effect on the severity of paratonia. The analysis also indicates that the effects of PMT and good supporting cushions can not be generalised to all limbs and movement directions.

Introduction

With the increase of the mean age of the Dutch population comes an increase in the prevalence of dementia patients. The overall prevalence of dementia in the Netherlands in 1997 was 6.2 per 1000 men and 14.8 per 1000 women (a total of 47,200 men and 115,200 women) [1]. Several studies indicate that these figures will rise by 40% by 2015 [1-4]. Patients with severe dementia develop a form of hypertonia called *paratonia*, which is different from spasticity and rigidity [5, 6]. Due to an increase of resistance in passive movements in paratonia, daily care becomes strenuous. It remains unclear what causes paratonia or its development, though the literature proposes neurophysiologic and biomechanical mechanisms [5, 7-23].

Dupré first used the term paratonia in 1910, defining it as 'the impossibility of voluntarily relaxing muscles' [9]. In clinical observation in 1927, Kleist identified a form of motor negativism in patients with severe dementia. He called this *Gegenhalten* [13]. In the Netherlands, Middelveld-Jacobs et al introduced the term paratonia in 1986 [6]; they described this form of hypertonia in severe dementia patients and defines it according to five criteria: 1) an increase in muscle tone during passive movement of the limbs, the head and the trunk, 2) appears in flexion and extension and is independent of the starting position, 3) increases with the speeding up of the movement, 4) decreases with the slowing down of the movement and 5) varies from mild to severe.

Beversdorf et al. suggested dividing paratonia into two distinct entities [7]: *facilitory* paratonia, or the inability to relax and move with the clinician; and *oppositional* paratonia, or an unwilling resistance to passive movement. If or when facilitory paratonia transfers into oppositional paratonia is unclear.

Scientific research of the phenomenon of paratonia was encouraged in 1999 by Waardenburg et al. They pointed out physiotherapists spend a lot of time and energy treating psychogeriatric patients with paratonia, yet with no certainty about the efficacy of their efforts [19].

Passive Movement Therapy (PMT) is the main physiotherapeutic intervention used when paratonia is obstructing daily care. Particularly in the Netherlands, however, multidisciplinary teams from Dutch nursing homes have cast doubt on the efficacy of PMT in the past decade, though carers and nurses claim it to have a modifying effect on the obstruction of daily care [18, 19, 21].

This study involved a partially blinded randomised clinical trial at the De Weerde nursing home in Eindhoven, the Netherlands, aiming to examine the effects of PMT on the severity of paratonia. It examines whether PMT has a positive short-term effect on the severity of paratonia and/or has a positive effect on the severity of paratonia after three weeks with a treatment frequency of three sessions per week, compared to good supporting cushions, one of the innovating ideas from the recent past. [18, 21]

Research design

Potential participants were selected according to the following in- and exclusion criteria. *Inclusion criteria*: features of paratonia according to Middelveld-Jacobs's five criteria, a minimum score of 5 on the Global Deterioration Scale, and proxy consent. *Exclusion criteria*: the presence of unstable pathology like bronchial infection or urinary tract infection, the use of muscle-relaxing medication, and already being in treatment with PMT. Nursing home physicians, physiotherapists and nurses were involved in this selection procedure.
By means of a blinded randomisation list composed in advance, the included patients were divided into three groups. Group 1 was given PMT according to Arnst et al.'s guidelines (see table 1) [5]. These guidelines and the order in which PMT should be given was explained in advance to the therapists. This order (first the left arm, then the right arm, the left leg and finally the right leg) corresponds with the order in which paratonia is assessed in this trial. The treatment session was expected to take about 15 minutes per patient. Group 2 received good supporting cushions according to the Van De Rakt method [18, 21] for about 25 minutes. A T-cushion was used to stabilise both legs and a normal soft pillow used for both arms. This treatment was given in line with verbal instructions by Van De Rakt via a telephone conference. Group 3, the control group, received no additional treatment.

Table 1. PMT guidelines according to Arnst et al.

1) Starting position	The position has a large influence on hypertonicity. Choose a position in which the patient moves comfortably. Maximum relaxation is often experienced in a symmetrical position.
2) Point of application	The point of application can differ per patient and even per limb. You may start centrally or choose a peripheral approach.
3) Force and speed	Apply PMT with minimal force and low speed.
4) Choice of movement	Search for a movement that causes the least tension and the largest range of movement.
5) Preservation of mobility increase	Use supporting cushions to maintain the mobility increase for a longer period.*
6) Pain	Avoid pain during PMT.

* In this trial the participants did not receive good supporting cushions after the treatment, as they were used only with group 2.

The treatments were given three times a week, with the intervention period spanning three weeks. This frequency is empirically based, and is often the treatment frequency used in the De Weerde nursing home and elsewhere. The treatments were scheduled between 8.00 a.m. and 9.30 a.m., before daily morning care.
Before and after each intervention the severity of paratonia was assessed using the modified Ashworth scale. Modified by Waardenburg et al., this 5-point scale has been validated by

experts in the field (face validity; see table 2) [19]. The assessments were applied to both arms and legs in four general movement directions: for the lower extremities, flexion and extension in hip and knee, abduction and adduction in hip with extension of the knee; and for the upper extremities, flexion and extension of shoulder and elbow, abduction and adduction of shoulder with extension of the elbow. All assessments were performed in the same sequence: left arm, right arm, left leg and finally right leg. To prevent the assessments being too similar to PMT, each assessment was carried out only once for each participant. A baseline assessment was carried out before the first treatment.

Table 2. The modified Ashworth scale

0	normal tone, passive movement no problem
1	mild paratonia, slight resistance in passive movement
2	moderate paratonia, enhanced resistance in passive movement
3	severe paratonia, severe resistance in passive movement
4	very severe paratonia, passive movement (almost) impossible

The assessors were trained by comparing the results of independent assessments of patients with severe and mild paratonia. These patients did not participate further in the trial. The therapists received instructions on how to perform PMT according to Arnst et al.'s guidelines, with exception of directions 1 and 6: All participants were treated lying in bed on their backs, without using supporting cushions as this would involve the alternative therapy (group 2).
Research in a clinical setting requires careful tuning with daily care. To guarantee this, a meeting was organised preceding the trial in which the research design was explained to all nursing home staff of the psychogeriatric department.

Data analysis

All data was analysed using SPSS 11.5. This was carried out in three stages. In the first stage, the short- and long-term effects were analysed for each movement direction for all four limbs separately. The average short-term effect was analysed by subtracting the results of all assessments after each treatment from the results before each treatment, and subsequently counting up these results and dividing them by 8. Differences between the three groups was analysed using One-way ANOVA.
Long-term effects were analysed by subtracting the eighth preassessment from the baseline assessment for each movement direction of all four limbs, showing the development of paratonia after a three–week treatment.
The second analysis was carried out in a similar manner for each movement direction, but adding up the results for both arms and both legs gave insight into the differences between the upper and lower extremities in all movement directions. In the third analysis the movement directions were also counted up, giving a total figure per upper and lower extremity and insight into the short- and long-term effects for both arms and both legs.

Results

Patients from the psychogeriatric ward from the De Weerde nursing home were selected over four months from February to May 2001. Of the 23 possible participants, 3 were already receiving PMT, 1 used muscle-relaxing medication, 2 had contractures rather than paratonia, and 2 were too fragile to participate. The remaining 15 patients participated in the trial: 1 man and 14 women with a mean age of 83 (70–97).

Their length of stay in the nursing home varied from 4 months to 8.5 years, with an average of 39 months.

Due to illness, the ninth and final treatment session for two participants was cancelled, along with the final assessments before and after this treatment. Given that both were assigned to group 1, our research team decided to cancel all final assessments and use the results for analyses up till the assessments before and after treatment 8

See Figure 1

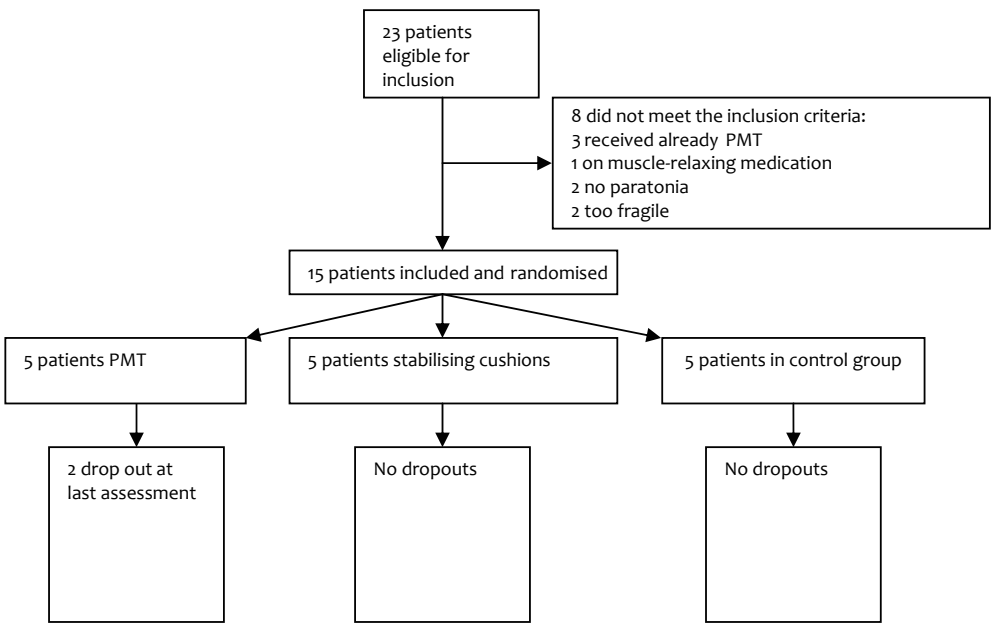

Figure 1. Trial profile

A total of 4320 ordinal numbers were used in the analyses. The two assessors were paired with the therapists and designated at random to the participants. The intervention and assessment took place in the participants' own bedrooms. The assessment was carried

out in a similar manner each time: The assessor entered the bedroom and gently woke the participant. After explaining the purpose of the visit, the blankets were pushed aside in order to assess both arms, then further to assess both legs. After the assessment the blankets were put back.
Between these assessments was a minimum of 30 minutes and a maximum of 60 minutes, with an average of 43 minutes. In this interval the intervention was given. The researchers were blinded to the interventions and the times of their visits coordinated throughout the four-month trial period.

The severity of the paratonia at baseline was comparable for all groups: groups 1, 2 and 3 had mean scores (SDs) of 25.0 (9.97), 25.4 (11.89) and 28.2 (7.98) respectively, with a *p* of 0.863 from ANOVA.
The average decrease or increase of paratonia is shown in tables 3 to 5. A positive score indicates a decrease of paratonia. The results of the statistical analysis of the short- and long-term effects of the treatment for groups 1, 2 and 3 on all separate movement directions of the single limbs are shown in table 3. The second analysis is shown in table 4, which presents the short- and long-term effects for groups 1, 2 and 3 for arms and legs in the separate movement directions. Finally the results of the third analysis are shown in table 5, in which all movement directions are clustered and the short- and long-term effects for the arms and legs are indicated.

Trends

The long-term effect on left leg extension was the only significant result (see table 3); no conclusion can be drawn from this. For this reason a trend analysis was conducted to search for certain patterns in the decrease or increase of paratonia between the three groups. In terms of short-term effect, there was a larger decrease of paratonia in the PMT group, especially in flexion, extension and abduction of the arms. In the legs, a positive result was found for extension. Over the long term, good supporting cushions had a positive trend for both arms in flexion and adduction. The long-term effect on both arms in the control group was not favourable: abduction in both arms in particular showed a negative effect (group 1 [0], group 2 [0] and group 3 [-0.8], *p*=0.069).
Furthermore, the analyses show that supporting cushions have a favourable short-term effect for both legs in flexion, which contrasts with the effect in extension. In both legs the largest decrease of paratonia appears in the control group; the decrease was even significant for the left leg compared with the PMT group and the group with supporting cushions: group 1 (0), group 2 (0.2) and group 3 (1) *p*=0.016.

Table 3. Short- and long-term effects on the severity of paratonia in all four limbs and all movement directions

	Group 1 mean (SD)	Group 2 mean (SD)	Group 3 mean (SD)	*P* value
Short-term effects				
Left arm flexion	0.3 (0.23)	0.175 (0.09)	0.225 (0.3)	0.721
extension	0.325 (0.44)	0 (0.29)	0.25 (0.42)	0.414
abduction	0.25 (0.38)	0.2 (0.34)	0.3 (0.3)	0.900
adduction	0.05 (0.07)	0.025 (0.43)	0.45 (0.23)	0.061
Right arm flexion	0.1 (0.14)	0.125 (0.36)	−0.1 (0.52)	0.595
extension	0.3 (0.21)	0.075 (0.19)	0 (0.32)	0.176
abduction	0.4 (0.38)	0.275 (0.35)	0.175 (0.31)	0.604
adduction	0.225 (0.33)	0.225 (0.18)	0.25 (0.12)	0.981
Left leg flexion	0.375 (0.42))	0.525 (0.43)	0.05 (0.32)	0.194
extension	0.475 (0.52)	0.1 (0.16)	0.2 (0.31)	0.282
abduction	0.4 (0.38)	0.25 (0.46)	0.2 (0.34)	0.714
adduction	0.225 (0.22)	0.075 (0.23)	0.2 (0.07)	0.428
Right leg flexion	0.175 (0.44)	0.2 (0.40)	0.15 (0.44)	0.983
extension	0.275 (0.44)	0.1 (0.14)	0.275 (0.27)	0.603
abduction	0.275 (0.33)	0.35 (0.44)	0.225 (0.18)	0.844
adduction	0.1 (0.05)	0.25 (0.29)	0.05 (0.21)	0.328
Long-term effects				
Left arm flexion	0 (1)	0 (1.2)	− 0.6 (1.6)	0.719
extension	−0.2 (0.45)	−0.2 (0.84)	0 (0.7)	0.868
abduction	0 (0.7)	−0.2 (1.1)	−1.2 (1.1)	0.161
adduction	0 (0.71)	0.2 (0.45)	−0.4 (0.55)	0.284
Right arm flexion	−0.6 (0.55)	0.4 (0.89)	0.4 (1.1)	0.167
extension	0.4 (0.55)	−0.2 (0.84)	0 (0.71)	0.420
abduction	0 (0.71)	0.2 (0.84)	−0.4 (0.89)	0.516
adduction	0 (0)	0.4 (0.55)	0.2 (0.45)	0.335
Left leg flexion	0.2 (0.45)	0.2 (1.30)	0.2 (0.84)	1
extension	0 (0.71)	0.2 (0.45)	1 (0)	*0.016*
abduction	0.4 (0.89)	0.4 (1.52)	0.4 (0.55)	1
adduction	−0.4 (0.55)	0 (0.71)	0.2 (1.30)	0.585
Right leg flexion	0.4 (0.55)	0.6 (1.14)	0.2 (0.84)	0.775
extension	0.2 (1.30)	−0.2 (0.84)	0.8 (0.84)	0.328
abduction	0 (1.22)	−0.4 (0.55)	0 (0.71)	0.713
adduction	−0.4 (0.55)	0.2 (1.09)	0.2 (0.84)	0.464

Table 4. Short- and long-term effects on the severity of paratonia in all movement directions in upper and lower extremities

	Group 1 mean (SD)	Group 2 mean (SD)	Group 3 mean (SD)	*P* value
Short-term effects				
Arms flexion	0.2 (0.13)	0.15 (0.23)	0.06 (0.35)	0.697
extension	0.31 (0.18)	0.04 (0.21)	0.125 (0.36)	0.282
abduction	0.325 (0.34)	0.24 (0.32)	0.24 (0.29)	0.883
adduction	0.14 (0.18)	0.125 (0.22)	0.35 (0.11)	0.123
Legs flexion	0.275 (0.42)	0.36 (0.39)	0.1 (0.32)	0.556
Extension	0.375 (0.47)	0.1 (0.11)	0.24 (0.27)	0.421
Abduction	0.34 (0.30)	0.3 (0.39)	0.21 (0.18)	0.803
adduction	0.16 (0.14)	0.16 (0.24)	0.125 (0.1)	0.921
Long-term effects				
Arms flexion	-0.3 (0.57)	0.2 (0.97)	-0.1 (0.65)	0.586
extension	0.1 (0.22)	-0.2 (0.45)	0 (0.5)	0.516
abduction	0 (0.61)	0 (0.5)	-0.8 (0.57)	0.069
adduction	0 (0.35)	0.3 (0.27)	-0.1 (0.41)	0.218
Legs flexion	0.3 (0.45)	0.4 (0.89)	0.2 (0.76)	0.910
Extension	0.1 (0.89)	0 (0.61)	0.9 (0.42)	0.107
Abduction	0.2 (1.04)	0 (0.93)	0.2 (0.45)	0.912
adduction	-0.4 (0.55)	0.1 (0.74)	0.2 (0.76)	0.368

Table 5. Short- and long-term effects on the total severity of paratonia in upper and lower extremities

	Group 1 mean (SD)	Group 2 mean (SD)	Group 3 mean (SD)	*P* value
Short-term effects				
arms	0.24 (0.14)	0.14 (0.19)	0.19 (0.18)	0.643
legs	0.29 (0.27)	0.23 (0.20)	0.17 (0.11)	0.669
Long-term effects				
arms	–0.05 (0.34)	0.07 (0.35)	–0.25 (0.31)	0.329
legs	0.05 (0.31)	0.12 (0.32)	0.37 (0.41)	0.344

Discussion

A partially blinded, randomised clinical trial was designed to enhance the study's validity [24, 25]. Likewise, possible confounding, selection and information bias was confined to a minimum to enhance internal validity. External validity, however, is difficult to assess.

The statistical power of this study is low due to the fact that only five participants per group were included. Restraint should therefore be exercised in interpreting the results. We used

two assessors and two therapists – which could have compromised reliability – for pragmatic reasons. However, Waardenburg et al.'s study shows that the modified Ashworth scale we used has high inter-rater reliability [19].

The participants in our study are representative of the psychogeriatric population in Dutch nursing homes, but due to poor diagnostic procedures did not form a homogenous group. The type of dementia was neither an inclusion nor exclusion criteria. Proper diagnosis is difficult in daily practice and often ambiguous [26, 27]. It appeared for most participants that after the initial diagnosis no additional diagnostic tests were administered. Attention should be paid to this in future research. The assessors and therapists in this trial noted qualitative differences in the paratonia between participants, which may result from different types of dementia or stages of the disease.

The modified Ashworth scale as introduced by Waardenburg et al. and used in this trial was a feasible assessment instrument and of no extra burden to the participants. Subtle distinctions, however, are difficult to identify with this instrument, which means accidental errors are possible. The 0 score of the modified Ashworth scale was often not a normal muscle tone as described by Waardenburg et al., yet was often noted as facilitory paratonia (*Mitgehen*), implying that both Gegenhalten and Mitgehen can occur in the same participant. PMT appears to be beneficial after one treatment, which supports carers' claims of a positive effect. However, the long-term effects of PMT are questionable. A positive short-term effect in both legs is visible when using stabilising cushions in flexion, yet with an adverse effect for extension. This makes the use of such cushions questionable, as they may hamper daily care. A change in biomechanical structures in the flexors may be a possible explanation for the trend of a negative long-term effect on leg extension in the PMT and supporting cushions groups in comparison with the control group.

Further research is necessary to investigate whether the trends found in this trial are actual effects. A larger and more homogenous research population is advisable for future research testing the effect of existing or yet-to-be-developed interventions for paratonia. To this end, close cooperation with neurologists and the use of additional diagnostic procedures is recommended. The description of participants' movement disorders should also be enhanced, and the focus of future research directed not only towards neurophysiologic but also biomechanical changes. Attention should be paid to improving the precision of the modified Ashworth scale so that in future it can be used in daily practice by physiotherapists and physicians to interpret their paratonia interventions on individual patients. Most important in this regard is a thorough consideration of the short- and long-term effects in different movement directions and limbs.

Conclusion

A trend analysis indicates that physiotherapeutic interventions can be effective, but PMT has no positive long-term effect on the severity of paratonia. The analysis also indicates that the effects of PMT and good supporting cushions cannot be generalised to all limbs and movement directions.

Acknowledgements

We thank all participating patients, relatives, carers, physicians and physiotherapists from the De Weerde nursing home, as well as Herman Maassen, Elise Mensink, colleagues from the ZorgBoog nursing home (Bakel), Jan van de Rakt, and finally Alison Edwards and Corien Gijsbers from the Maastricht University Translation and Editing Department.

References

1. Maas IAM, Gijsen R, Lobbezoo IE, Poos MJJC: **Volksgezondheid Toekomst verkenning 1997 [1997 Public health predictive study]].** In: De gezondheidstoestand, een actualisering RIVM. Elsevier/ De Tijdstroom; 1997.
2. Verpleeghuizen in cijfers, 1998, informatie uit LVZ en SIVIS [Nursing homes in figures, 1998, information from LVZ and SIVIS]. Utrecht: Arcares; 1998.
3. Idenburgh PA, Ketting E, Bijl RV. In: **Zorgen voor geestelijke gezondheid [Caring for mental health].** Utrecht/Antwerp: Bohn, Scholtema en Holkema; 1990.
4. Leufkens HGM, van Rijthoven PFPJ (eds.): **Viermaal een doorkijk in de biologische psychiatrie [Four cases in biological psychiatry].** Lochum: De Tijdstroom; 1999.
5. Arnts W, Van Oostwaard P, Rooyakkers A: **physiotherapy treatment for paratonia.** Nederlands Tijdschrift voor Fysiotherapie 1989, 99:216-220.
6. Middelveld-Jacobs I, Van den Boogerd M: **Paratonia, a form of hypertonia in a nursing home population.** Nederlands Tijdschrift voor Fysiotherapie 1986, 96:85-87.
7. Beversdorf DQ, Heilman KM: **Facilitory paratonia and frontal lobe functioning.** Neurology 1998, 51(4):968-971.
8. Chatterjee A: **Feeling frontal dysfunction: facilitory paratonia and the regulation of motor behavior.** Neurology 1998, 51(4):937-939.
9. Dupré E: **Débilité mentale et débilité motrice associées.** Rev Neurol 1910, 20(semestre 2):54-56.
10. Franssen EH, Kluger A, Torossian CL, Reisberg B: **The neurologic syndrome of severe Alzheimer's disease.** Relationship to functional decline. Arch Neurol 1993, 50(10):1029-1039.
11. Funkenstein HH, Albert MS, Cook NR, West CG, Scherr PA, Chown MJ, Pilgrim D, Evans DA: **Extrapyramidal signs and other neurologic findings in clinically diagnosed Alzheimer's disease.** A community-based study. Arch Neurol 1993, 50(1):51-56.
12. Galasko D, Kwo-on-Yuen PF, Klauber MR, Thal LJ: **Neurological findings in Alzheimer's disease and normal aging.** Arch Neurol 1990, 47(6):625-627.
13. Kleist K: **Gegenhalten (motorischer negativismus) zwangsgreifen und thalamus opticus.** Monatchr Psychiat Neurol 1927, 65:317-396.
14. Kwakkel G, Wagenaar RC, Kollen BJ, Lankhorst GJ: **Predicting disability in stroke – a critical review of the literature.** Age Ageing 1996, 25(6):479-489.
15. O'Keeffe ST, Kazeem H, Philpott RM, Playfer JR, Gosney M, Lye M: **Gait disturbance in Alzheimer's disease: a clinical study.** Age Ageing 1996, 25(4):313-316.
16. Selkoe DJ: **Aging brain, aging mind.** Sci Am 1992, 267(3):134-142.
17. Souren LE, Franssen EH, Reisberg B: **Neuromotor changes in Alzheimer's disease: implications for patient care.** J Geriatr Psychiatry Neurol 1997, 10(3):93-98.
18. Van de Rakt J: **The development of a fetal position in psychogeriatric patients; a hypothesis.** Fysiotherapie en ouderenzorg 1997(juni):2-6.
19. Waardenburg H, Elvers W, Van Vechgel F, Oostendorp R: **Can paratonia be measured reliably? Evaluation of the reliability of a visual analogue scale and the modified tonus scale of Ashworth for measuring paratonia.** Nederlands Tijdschrift voor Fysiotherapie 1999, 102(2):30-35.

20. Denny-Brown D: **Disintegration of motor function resulting from cerebral lesions.** J Nerv Ment Dis 1950, 112(1):1-45.

21. Van de Rakt J: **Foetale houding [Foetal position] (unpublished).** 2001.

22. van Eijle J: **Werkboek PDL.** Middelharnis: Mobicare; 1991.

23. van Gennep M: **Fysiotherapie en dementie [Physiotherapy and dementia].** In: Jaarboek fysiotherapie 1999. Houten: Bohn, Stafleu, van Loghum; 1999.

24. Bouter LM, C.J.M. vDM: **Epidemiologisch onderzoek, opzet en interpretatie [Epidemiological research, design and interpretation].** Houten/Diegem: Bohn, Stafleu, van Loghum; 1995.

25. 't Hart H, van Dijk J, de Goede M, Jansen W, Teunissen J: **Onderzoeksmethoden [Research methods].** Amsterdam/Meppel: Boom; 1996.

26. Boersma F, Eefsting JA: **Dementie in een Nederlandse plattelandspopulatie: prevalentie, diagnostiek, zorg en beloop [Dementia in a Dutch rural population: prevalence, diagnostics, care and course].** Amsterdam: Vrije Universiteit; 1996.

27. Deberdt W, Brems A: **The assessment of quality of life in nootropic drug research: some questions.** In: Dementia: Molecules, methods and measures. Edited by Hippius H, Wilcock GK. New York: John Wiley and Sons Ltd; 1991.

3

Paratonia: A Delphi Procedure for Consensus Definition

Authors:
Hans Hobbelen
Raymond Koopmans
Frans Verhey
Roland van Peppen
Rob de Bie

Published in: Journal of Geriatric Physical Therapy 2006;29:50-56

Abstract

Background and Purpose:
Paratonia is a motor problem that develops during the course of dementia. Definitions of paratonia used in the literature differ considerably, which has clinical implications and may lead to an undesirable heterogeneity in study populations. For this reason, we initiated a Delphi procedure with known experts in the field to establish an operational consensus definition of paratonia.

Methods:
The Delphi procedure involved an anonymous and multistage approach presented as a questionnaire, with each stage building on the results of the previous one in order to reach consensus on the definition of paratonia.

Results:
Eight of 17 experts agreed to participate in the study. After 4 rounds, the participants reached consensus on the following definition: paratonia is a form of hypertonia with an involuntary variable resistance during passive movement. The nature of paratonia may change with progression of dementia (eg, from active assistance (also known as Mitgehen) to active resistance). The degree of resistance depends on the speed of movement (eg, slow; low resistance, fast; high resistance). The degree of paratonia is proportional to the amount of force applied and increases with progression of dementia. The resistance to passive movement is in any direction and there is no clasp-knife phenomenon.

Conclusion:
The Delphi procedure resulted in a comprehensive, operational definition of paratonia. Future research should focus on the reliability and validity of this definition.

Key Words: paratonia, dementia, Delphi, movement disorders

Introduction

Dementia is becoming an increasing problem worldwide, with an estimated prevalence of 25 million people in the year 2000 and a projected prevalence of 63 million by 2030.[1] Although movement disorders, which have a different underlying cause, are common in dementia, they are often not accurately described and are usually diagnosed as Parkinsonian or extrapyramidal signs, with rigidity, slowness, and impaired gait.[2-6] Paratonia is a common motor problem seen in individuals with dementia. Dupré first described it in 1910 as the inability to relax muscles in combination with a mental disorder.[7] In 1927, Kleist noted a similar phenomenon in his clinical observations of patients in a late stage of dementia.[8] He observed motor negativism and called it Gegenhalten.

Carers and nurses find it difficult to wash and dress patients with paratonia because the problem is associated with a loss of mobility and with the development of contractures, especially in the late stages of the dementia.[9-11] Passive movement therapy, to decrease high muscle tone and to sustain range of motion of affected joints, is the main therapy applied. However, in a pilot study of the efficacy of this intervention, we found that passive movement therapy seemingly worsened the joint and limb stiffness.[12] Unfortunately, the study was underpowered, and because of the lack of a clear operational definition of paratonia, the study population was heterogeneous.

Paratonia differs from spasticity, which Lance defined as a motor disorder characterized by velocity dependent increase in the tonic stretch reflex with exaggerated tendon jerks. Parkinsonian rigidity on the contrary is defined as a resistance to passive movement of the limb whereby the degree of resistance is constant whether the limb is moved slowly or rapidly (like bending a lead pipe).[6,13] However, differentiation with paratonia is hampered by inconsistent and even contradictory definitions of paratonia used in the various published studies. Most authors define paratonia as a resistance to passive movement or a sudden increase in muscle tone with accompanying elements like cogwheeling and Mitgehen (ie, actively assisting passive movement) and several factors that influence the degree of paratonia such as the amplitude and irregularity of passive movement, external stimuli (eg, sound and light), deep sleep, and the use of antipsychotic drugs.[6,9-12,1419,21-22] Furthermore, it is not known whether paratonia initially emerges in the lower or upper limbs or if it develops in a distinct pattern.[17,19] Most authors mention that the degree of paratonia can be influenced by the amount of force applied and that it depends on the speed of movement, in which a forceful fast movement results in the most resistance.[6,9,11,15,16,18,19,21] Some authors state that paratonia is more pronounced when the patient is instructed to relax and not by clinching of the contralateral fist and that it is characterized by the absence of a clasp-knife phenomenon.[9,11,16,18,21]

To give clinicians a useful tool to diagnose paratonia in daily practice and to differentiate it from other movement disorders, we initiated a Delphi procedure in which known experts in the field participated and reached consensus on the definition of paratonia. Here, we describe this procedure and list the most essential elements defining paratonia.

Methods

The Delphi procedure is an instrument to reach consensus on a particular issue.[23,24] The procedure entails a questionnaire for a panel of informed experts in a specific field. Once responses are collected the data are summarized and a new questionnaire is designed based on the former results. The respondents are asked to reconsider their initial opinion in light of the group results. This anonymous process is repeated at least once, yet preferably more often, in order to reach consensus.[23,24]

We contacted experts with special expertise in paratonia and spasticity and/or rigidity and/or contractures in dementia, in order to get as broad a perspective on paratonia as possible. All authors of papers (in Dutch or English) identified by searches in MEDLINE, EMBASE, CINAHL, PsychINFO, and PEDro, in which paratonia was either the subject or was contrasted with spasticity or rigidity, were considered experts and possible participants. We preferred participants with a background in physical therapy.

In order to achieve consensus on the definition of paratonia we designed a questionnaire in which we classified available information on paratonia into 3 categories: short descriptions, influencing factors, and differentiating elements. First, we compiled a list of 12 commonly used short descriptions of paratonia.Then we selected 8 factors that influence the degree of paratonia. And finally, we identified 15 features that potentially differentiate paratonia from muscle spasm, contractures, and Parkinson rigidity.

We asked the participants to rate these 35 items on a 5-point Likert scale (1= Not important at all, 2= Somewhat important, 3= Moderately important, 4= Very important, and 5= Extremely important) and to provide additional items for each category. In the subsequent consultation rounds, the participants were asked to rate the newly provided items and to review their initial rating in the light of the calculated group median for each item. Furthermore, we asked the participants to provide a cut-off score for each category. Items with a score equal to or higher than this cut-off score were considered essential for a proper definition of paratonia. All items with a score lower than this cut-off score or with ratings with a wide range (ie, no consensus between the participants) were discarded. In the fourth round, the final results were presented and the participants were asked if they agreed that the remaining items reflected a proper definition of paratonia (Figure 1). In all 4 rounds, the participants were invited to comment on the items presented, their own rating, the calculated group medians, and the final result.

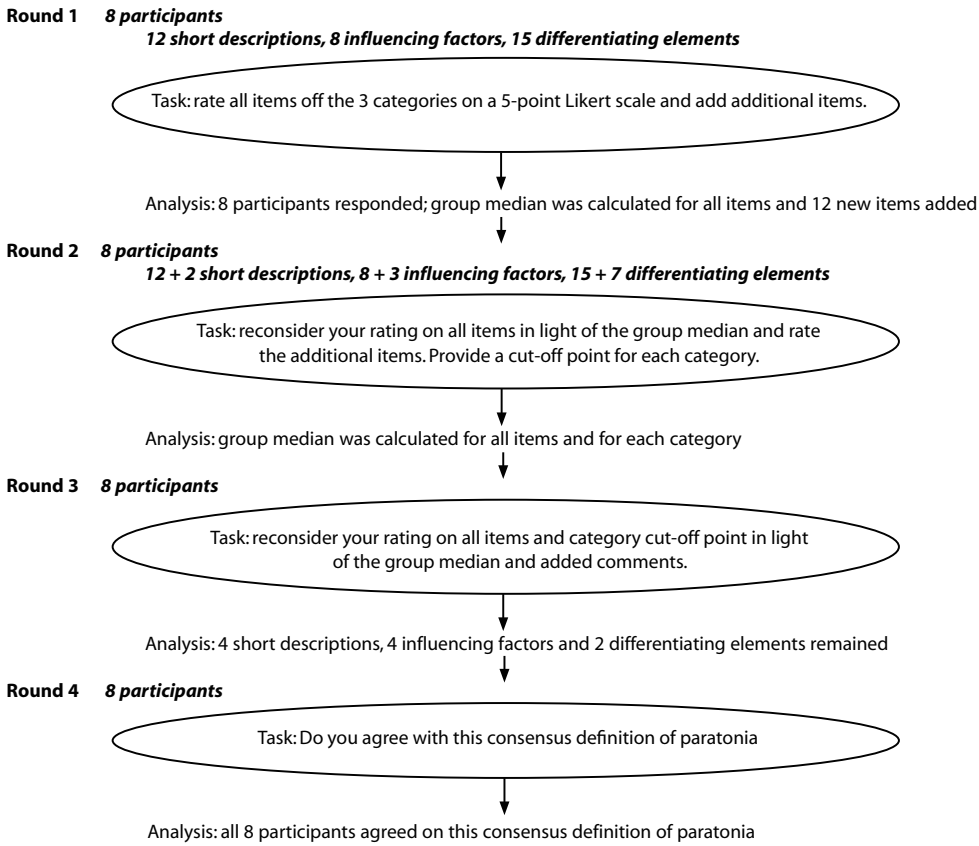

Figure 1. Flow chart Paratonia Delphi Procedure.

Results

We contacted 17 experts by e-mail and telephone,of whom 8 agreed to participate (see appendix; 3 from the Netherlands, 2 from the United States of America, 2 from the United Kingdom, and 1 from Australia). The other experts did not participate for reasons not related to the topic of this survey (ie, time constraints). All participants completed the project and were blind to the identity of the other participants during the Delphi procedure. The interval between each of the 4 rounds was about 5 weeks.

In the first round, the participants provided 2 additional short descriptions, 3 additional influencing factors, and 7 new differentiating elements. In the second and third rounds, 7 of the participants changed some of their ratings, which resulted in a greater similarity of scores. All participants added comments on several of the items during the first 3 rounds (Table 1).

Table 1. the delpi procedure original list of short descriptions, influencing factors and differentiating elements of paratonia (with references in suprascript).

Description of phenomenon: Paratonia is	*Group Median After 1st round*	*Group Median After 2nd round*	*Group Median After 3rd round*
An alteration of tone to passive movement [14,16,22]	3	3	3
A resistance to passive movement [6,10,14-17,19-20]	5	5	5
A sudden increase in muscle tone [9-11,15-16]	2	2	2
An involuntary resistance [10-11,19]	4.5	5	5
A progressively increasing resistance [18]	2.5	2	2
An irregular resistance [9,15,18]	3	3	3
An active resistance to changes in limb position[6,18-20]	3.5	3	3
An active resistance to, or an active assistance (Mitgehen) of, passive movement [6,14]	2.5	2.5	2.5
A variable resistance during passive movement [9,15]	3.5	3.5	3.5
A form of hypertonia [11]	3.5	3.5	4
A form of rigidity [6]	2.5	2.5	2.5
Frozen in place [18-19,27]	1	1	1
Additional short descriptions provided by the participants in the first Delphi-round. Paratonia is:			
An umbrella term to denote phenomena of muscle activity observed during functional activities requiring postural control that cannot be ascribed to forms of spasticity and rigidity		1.5	1
A combination of spasticity and rigidity in different grades		3.5	3.5
Influencing factors:			
The degree of paratonia is proportional to the amount of force applied [9,15-16,18-19,21]	4	4	4
The degree of resistance varies depending on the speed of movement; slow → decrease, fast → increase [6,9,11,15]	4.5	4.5	4.5
The degree of paratonia is proportional to the amplitude of the passive movement [9,16,21]	3	3	3
The degree of paratonia is proportional to the degree of irregularity of the passive movement [9,16]	2	2	2
More pronounced by instructing the patient to relax [9,11,16,18]	2	2	2.5
External stimuli (e.g. sound and light) elicit a paratonic response [15]	2	2	2
Hypertonia decreases in deep sleep [15]	3	3	3
Paratonia increases with progression of the dementia [9-11,15,21,25-26]	4	4	4
Additional influencing factors:			
Improves with distraction (e.g. asking the patient to count or to clench the contralateral fist)		3	3
With the first movement you experience the most resistance, the second and third movement with the same limb and in the same direction the resistance is less.		2.5	2.5

The nature of the paratonia may change with progression of the dementing illness (eg. Early in the course of degenerative dementias, active assistance is more common and later of the disease active resistance is more common)		5	5
Differentiating elements:			
Different grades of hypertonia are present in different parts of the body [9,15]	3	3	3
No distinct pattern [9,15]	1	1	1
The presence of Mitgehen (= actively assisting passive movement) suggests that the quality of rigidity is paratonic [6,22]	3	2	2
Not on anti-psychotic drug therapy [17]	2	2	2
No exacerbation by movement of the contralateral fist [16,21]	2.5	3	3
Cog wheeling **can** occur [6]	3	3	3
No cog wheeling [9,11,16,21]	1	1	1
No clasp-knife phenomenon [11,16]	4.5	5	5
Occurs usually in the lower limbs [16,18]	1	1	1
Occurs usually in the upper extremities [16]	3	3	3
Paratonia is independent of the starting position of the joint [15]	3	3	3
The increased muscle tone is throughout the range of motion [17]	3.5	3.5	3.5
The resistance to passive movement is in **any** direction [9,15,17-18]	4.5	5	5
Correlates highly with echopraxia (= a tendency to imitate movements of others) [22]	1.5	2	2
Correlates highly with the inability to inhibit eye-movements to peripheral stimuli [22]	1	1	1
Additional differentiating elements:			
A distinct pattern: head and trunk in extension, arms in adduction/flexion and legs in extension (with possible flexion component)		2.5	2.5
May observe variation with time of day		2	2
May observe day-to-day variation		2.5	2.5
Can change with different positions in relation to size of base; smaller base of support→ increase of paratonia		3	2
The presence of eyelid paratonia (resistance to passive raising of the eyelids) suggests that the quality of limb rigidity is paratonic		2	2
Contralateral reinforcement increases tremor, bradykinesia and rigidity but reduces paratonia.		3	3
These patients have a general high muscle tone on which the resistance to passive movement is superimposed		2	2

We asked the participants to rate these items on a 5-point Likert scale (1= Not important at all, 2= Somewhat important, 3= Moderately important, 4= Very important and 5= Extremely important) and we calculated the group median after each round.

The final results are presented in Table 2.Four short descriptions of paratonia had scores higher than the group median cut-off score of 3.5:"A resistance to passive movement"(median score of 5), "An involuntary resistance" (median score of 5), "A form of hypertonia" (median score of 4.5) and "A variable resistance during passive movement" (median score of 3.5). No consensus was reached on the item "A combination of spasticity and rigidity in different grades"

Table 2. final results after 4 delphi questionnaires.

Group median	*Description of phenomenon: Paratonia is (Group median cut-off point 3,5)*
5	A resistance to passive movement
5	An involuntary resistance
4	A form of hypertonia
3.5	A variable resistance during passive movement
	Influencing factors (Group median cut-off point 3)
5	The nature of the paratonia may change with progression of the dementing illness (e.g. Early in the course of degenerative dementias, active assistance (Mitgehen) is more common and later of the disease active resistance is more common).
4.5	The degree of resistance varies depending on the speed of movement; slow → decrease, fast → increase
4	The degree of paratonia is proportional to the amount of force applied
4	Paratonia increases with progression of the dementia
	Differentiating elements (Group median cut-off point 3,75)
5	No clasp-knife phenomenon
5	The resistance to passive movement is in **any** direction

We asked the participants to provide a cut-off score for each category. Items with a score equal to or higher than this cut-off score were considered essential for a proper definition of paratonia.

The factors identified as influencing the severity of paratonia had a group median cut-off score of 3. After analysis, 4 factors remained: "The nature of the paratonia may change with progression of the dementing illness (eg, early in the course of degenerative dementias, active assistance [Mitgehen] is more common and later in the disease active resistance is more common)" (median score of 5),"The degree of resistance varies depending on the speed of movement; slow ‡ decrease, fast ‡ increase" (median score of 4.5),"The degree of paratonia is proportional to the amount of force applied" (median score of 4) and "Paratonia increases with progression of dementia" (median score of 4). Three items were discarded because there was no agreement on their relevance (scores had a large range): "Improves with distraction,""The degree of paratonia is proportional to the amplitude of passive movement," and "Hypertonia decreases in deep sleep." Only 2 of 22 differentiating items had scores higher than the median cut-off score of 3.75: "No claspknife phenomenon" and "The resistance to passive movement is in any direction". Both had a group score of 5.0.

In the concluding fourth round, all participants agreed on the generated consensus description of paratonia. The description is presented in Figure 2.

Paratonia is a form of hypertonia with an involuntary variable resistance during passive movement. The nature of paratonia may change with progression of the dementing illness (eg, active assistance (aka Mitgehen) is more common early in the course of degenerative dementias, whilst active resistance is more common later in the course of the disease). The degree of resistance varies depending on the speed of movement (eg, a low resistance to slow movement and a high resistance to fast movement). The degree of paratonia is proportional to the amount of force applied. Paratonia increases with progression of dementia. Furthermore, the resistance to passive movement is in any direction and there is no clasp-knife phenomenon.

Figure 2. The consensus definition of paratonia

Discussion

This Delphi procedure established a useful and comprehensive definition of paratonia. However, our study had some limitations. First, the small number of participants may have influenced the validity of the definition. Second, this Delphi procedure was conducted in English, yet 3 participants were not native English speakers, which could be a source of bias. Third, the participants work with patients in different stages of dementia. Some participants work solely with patients with early dementias while others work only with patients in the advanced stages of the disease. This diversity meant that it was not possible to achieve agreement on the relevance of some items, specifically those items in which paratonia changes over time. For example, in early dementia it is still possible to communicate with the patient and to observe if paratonia improves when the patient is distracted by asking him/her to count or to clench the contralateral fist. However, in an advanced stage this becomes impossible. Conversely, in the final stages of the disease a distinct pattern becomes visible with head and trunk in extension, arm in adduction/flexion, and legs in extension; whereas this pattern is not obvious in the early stages of dementia. Yet this diversity may be a strength of the study in that the definition covers paratonia of different stages of dementia. In this way, it became obvious that while paratonia can give the impression of being a combination of spasticity and rigidity of different severity, spasticity is not a part of paratonia and there is no clasp-knife phenomenon.

This project highlights the uncertainties surrounding the problem of paratonia. For example, one of the most discussed items that emerged from this Delphi procedure involved Mitgehen. Most participants agreed that Mitgehen is in some way a part of paratonia and is mainly present in the early stages of dementia, but some participants questioned this, maintaining that it is impossible to distinguish Mitgehen from a normal inability to relax. The contribution of neurophysiological and biomechanical factors to paratonia was also a matter of discussion. Paratonia is hypothesized to develop centrally but to exert an effect on peripheral biomechanics.[9-12] However, in clinical practice, it is difficult to distinguish between central neurophysiological and peripheral biomechanical factors. This was illustrated by

the very different scores given to the item on the effect of the amplitude of the passive movement on the degree of paratonia. Furthermore, it is unclear whether paratonia can be felt throughout the whole range of motion, whether it is independent of the starting position of the joint, and whether cogwheeling can occur with paratonia.

This operational definition of paratonia should be seen as a first step to a better understanding of the motor disturbances of dementia. With this definition differentiation between paratonia and Parkinsonian rigidity and spasticity should be possible. Contrary to paratonia, Parkinsonian (Lead Pipe) rigidity has a constant degree of resistance which is not influenced by the speed of the movement.[6] In contrast with the Lance definition of spasticity, there are in paratonia no exaggerated tendon jerks (no clasp-knife phenomenon).[13] With this consensus definition it becomes clear that most authors used a less restrictive definition, especially according to the differentiation with spasticity, making the results of these studies difficult to interpret. The definition used by Paulson et al, Souren et al, and Kurlan et al are very close to our established description of paratonia.[6,9,11]

Conclusions

By using the Delphi procedure we have established a comprehensive,operational definition of paratonia.This operational definition of paratonia should be seen as a first step to a better understanding of the motor disturbances of dementia. More research is needed. For instance, cross-sectional or preferably longitudinal research should focus on the reliability and validity of this definition and on the ambiguous items, to clarify whether they contribute to the description of paratonia. Only when these uncertainties are removed will it be possible to search for an effective intervention.

Acknowledgements

We thank Louise Ada, John Branten, Anjan Chatterjee, Roger Kurlan, Valerie Pomeroy, Jan van de Rakt, Pippa Tyrrell and Charles Verschuren for participating in the Delphi procedure. We also thank Jane Sykes for her corrections of the English language used in this manuscript. This study was supported by a grant from the Vitalis Zorg Groep Eindhoven.

References

1. Wimo A, Winblad B, Aguero-Torres H, von Strausss E. **The magnitude of dementia occurence in the world.** Alzheimer Dis Assoc Disord. 2003;17:63-67.
2. Funkenstein HH, Albert MS, Cook NR, et al. **Extrapyramidal signs and other neurologic findings in clinically diagnosed Alzheimer's disease.** Arch Neurol. 1993;50:51-56.
3. Galasko D,Kwo-on-Yuen PF,Klauber MR,Thal LJ. **Neurological findings in Alzheimer's disease and normal aging.** Arch Neurol. 1990;47:625-627.
4. O'Keeffe ST, Kazeem H, Philpott RM, Playfer JR, Gosney M, Lye M. **Gait disturbance in Alzheimer's disease.** Age Ageing. 1996;25:313-316.
5. Selkoe DJ. **Aging Brain, Aging Mind.** Sci Am. 1992:97-103.
6. Kurlan R, Richard IH, Papka M, Marshall F. **Movement disorders in Alzheimer's Disease: more rigidity of definitions is needed.** Mov Disord. 2000;15:24-29.
7. Dupré E. **Débilité mentale et débilité motrice associées.** Rev Neurol. 1910;20:54-56. (article in French)
8. Kleist K. **Gegenhalten (motorischer negativismus) zwangsgreifen und thalamus opticus.** Monatschr Psychiat Neurol 1927;65:317-396. (article in German)
9. Souren LEM, Franssen EH, Reisberg B. **Neuromotor changes in Alzheimer's disease: implications for patient care.** J Geriatr Psychiatry Neurol. 1997;10:93-98.
10. Franssen EH, Kluger A, Torossian CL, Reisberg B. **The neurologic syndrome of severe Alzheimer's disease.** Relationship to functional decline. Arch Neurol. 1993;50:1029-1039.
11. Paulson G, Gottlieb G. **Development reflexes: the reappearance of foetal and neonatal reflexes in aged patients.** Brain. 1968;91:37-52.
12. Hobbelen JSM, de Bie R, van Rossum E. **Effect of passive movement on severity of paratonia:a partially blinded, randomized clinical trial.** Ned Tijdschr Fysiother. 2003;113:132-137. (article in Dutch)
13. Lance JW. **Symposium synopsis.** In: Feldman RG, Young RR, Koella WP, eds. Spasticity: Disordered Motor Control. Chicago, Ill: Year Book Medical Publishers; 1980:485.
14. Beversdorf DQ, Heilman KM. **Facilitory paratonia and frontal lobe functioning.** Neurology. 1998;51:969-971.
15. Middelveld-Jacobs IM, Van den Boogerd MECP. **Paratonia, a form of hypertonia in a nursing home population.** Ned Tijdschr Fysiother. 1986;96:85-87. (article in Dutch)
16. Tyrrell P, Rossor M. **The association of gegenhalten in the upper limbs with dyspraxia.** J Neurol Neurosurg Psychiatry. 1988;51:995-997.
17. Risse SC, Lampe TH, Bird TD, et al. **Myoclonus, seizures and paratonia in Alzheimer disease.** Alzheimer Dis Assoc Disord. 1990;4:217-225.
18. Gladstone DJ, Black SE. **The Neurological Examination in Aging, Dementia and Cerebrovascular Disease.** part 2: Motor Examination. Geriatrics and Ageing 2002;5:44-49.
19. Joseph R. **Frontal lobe psychopathology:mania,depression, confabulation, catatonia, perseveration, obsessive compulsions and schizophrenia.** Psychiatry. 1999;62:138-166.

20. Sweet RA, Akil M, Mulsant BH, Ulrich R, Pasternak RE, Zubenko GS. **Determinants of spontaneous extrapyramidal symptoms in elderly psychiatric inpatients diagnosed with Alzheimer's disease, major depressive disorder, or psychotic disorders.** J Neuropsychiatry Clin Neurosci. 1998;10:68-77.

21. Tyrrell PJ, Sawle GV, Ibanez V, et al. **Clinical and positron emission tomographic studies in the 'extrapyramidal syndrome' of dementia of the Alzheimer type.** Arch Neurol. 1990;47:1318-1323.

22. Chatterjee A. **Feeling frontal dysfunction.** Neurology. 1998;51:937-939.

23. O'Hara L, De Souza LH, Ide L. **A Delphi study of self-care in a community population of people with multiple sclerosis.** Clin Rehab. 2000;14:62-71.

24. McKenna HP. **The Delphi technique: a worthwhile research for nursing?** J Adv Nurs. 1994;19:1221-1225.

25. Koopmans RCTM, van Hell ME, de Jongh F, Froeling PGAM, van den Hoogen HJM,van Weel C. **The course of Alzheimer's disease in a nursing home population: epidemiological aspects, (co) morbidity and mortality.** Ned Tijdschr Geneesk. 1991;135:845-850. (article in Dutch)

26. O'Keeffe ST, Kazeem H, Philpott RM, Playfer JR, Gosney M, Lye M. **Gait disturbance in Alzheimer's disease.** Age Ageing. 1996;25:313-316.

27. Tweedy J, Reding M, Garcia C, Schulman P, Deutsch G, Antin S. **Significance of cortical disinhibition signs.** Neurology. 1982;32:169-173.

Appendix.
Participants Paratonia Delphi procedure

* Dr Pippa Tyrrell MD FRCP Senior Lecturer in Stroke Medicine and Hon Consultant Stroke Physician Hope Hospital, Salford, United Kingdom
* Professor Valerie M Pomeroy Professor of Rehabilitation for Older People Centre for Rehabilitation and Ageing Geriatric Medicine St George's Hospital Medical School London, United Kingdom
* Prof. Roger Kurlan Movement and Inherited Neurological Disorders Unit Mt. Hope Professional Building Rochester, New York , United States of America
* Louise Ada, PhD Senior Lecturer,School of Physiotherapy Faculty of Health Sciences The University of Sydney, Australia
* Anjan Chatterjee, MD Associate Professor of Neurology Philadelphia, United States of America
* John Branten Geriatric physiotherapist Head of the physiotherapy department Nursinghome Joachim en Anna, Stichting de Waalboog Nijmegen, the Netherlands
* Jan van de Rakt Physiotherapist and NDT teacher IBITA Nursinghome Waelwick, Ewijk, the Netherlands
* Drs. Charles Verschuren, Msc, PT Physiotherapist/ human movement scientist Head of the geriatric rehabilitation department, Vitalis Zorggroep Eindhoven, The Netherlands

4

Diagnosing paratonia in the demented elderly: reliability and validity of the Paratonia Assessment Instrument (PAI)

Authors:
Hans Hobbelen
Raymond Koopmans
Frans Verhey
Kitty Habraken
Rob de Bie

Published in: International Psychogeriatrics 2008;20:840-852

Abstract

Background:
Paratonia is one of the associated movement disorders characteristic of dementia. The aim of this study was to develop an assessment tool (the Paratonia Assessment Instrument, PAI), based on the new consensus definition of paratonia. An additional aim was to investigate the reliability and validity of the PAI.

Methods:
A three-phase cross-sectional survey was conducted. In the first two phases, the PAI was developed and validated. In the third phase, the interobserver reliability and feasibility of the instrument was tested.

Results:
The original PAI consisted of five criteria that all needed to be met in order to make the diagnosis. On the basis of a qualitative analysis, one criterion was reformulated and another was removed. Following this, interobserver reliability between the two assessors resulted in an improvement of Cohen's κ from 0.532 in the initial phase to 0.677 in the second phase. This improvement was substantiated in the third phase by two independent assessors with Cohen's κ ranging from 0.625 to 1.

Conclusion:
The PAI is a reliable and valid assessment tool for diagnosing paratonia in elderly people with dementia that can be applied easily in daily practice.

Key words: paratonia, assessment instrument, dementia, movement disorders

Introduction

Movement disorders with different underlying pathophysiologies are common in patients with dementia.[1-4] Unfortunately, these movement disorders are often inaccurately described and are usually diagnosed as parkinsonian or extrapyramidal signs, with rigidity, slowness, and impaired gait.[5] Failure to characterize more precisely the motor disturbances seen in dementia can lead to improper use of anti-parkinsonian medication and a stagnation of further understanding of the clinical phenomenology, neurobiology and therapy.[5] Paratonia is one of the associated movement disorders seen in dementia patients, and was first described by Dupré in 1910 as the inability to relax muscles in combination with a mental disorder.[6] Paratonia is hypothesized to develop centrally, but also to exert an effect on peripheral biomechanics. It is associated, especially in the late stages of dementia, with a loss of mobility and with the development of contractures.[7,8] It has been suggested that patients who develop paratonia represent a subtype of Alzheimer's disease (AD) with a more rapid decline (Gladstone and Black, 2002), and that the presence of paratonia might be a marker for executive and planning impairments.[9,10] Furthermore, it is hypothesized that the general decline of propriocepsis and exterocepsis invokes sensory deprivation, thus furthering the development of paratonia.[11] Unfortunately, definitions of paratonia used in the various published studies lack consistency and are, in some respects, even contradictory.[6-9,12-16] Making clinical distinctions between paratonia, parkinsonian rigidity, and spasticity after stroke is therefore difficult. This, in turn, not only hampers an accurate analysis of the etiology but also impedes the development and application of adequate treatment strategies.

Consequently, we initiated a Delphi procedure with known experts from various parts of the world in order to reach consensus on the following operational definition of paratonia [17]:

> Paratonia is a form of hypertonia with an involuntary variable resistance during passive movement. The nature of paratonia may change with progression of the dementing illness (e.g. active assistance (Mitgehen) is more common early in the course of degenerative dementias, whilst active resistance is more common later in the course of the disease).
>
> The degree of resistance varies depending on the speed of movement (e.g. a low resistance to slow movement and a high resistance to fast movement). The degree of paratonia is proportional to the amount of force applied. Paratonia increases with progression of dementia. Furthermore, the resistance to passive movement is in any direction and there is no clasp-knife phenomenon.

With this definition, differentiation between paratonia, parkinsonian rigidity, and spasticity after stroke should be possible. Unlike paratonia, parkinsonian (lead pipe) rigidity has a

constant degree of resistance which is not influenced by the speed of the movement.[5] Furthermore, in paratonia, there are no exaggerated tendon jerks (clasp-knife phenomenon) in contrast to spasticity as stated in the frequently used Lance definition.[18]

The next step was to develop an assessment instrument of paratonia based on the consensus definition. The possibility of an instant diagnosis of paratonia, even in the early stages of dementia, is important in daily practice for an accurate treatment strategy and to prevent the adverse effects of declining mobility, such as the development of contractures or pressure ulcers. It will also enhance the possibilities for future research on movement disorders in dementia and may even initiate the development of a general tool for clinicians which could lead to a better differential diagnosis and therefore also a more accurate prognosis. This paper is a report on the development of the Paratonia Assessment Instrument (PAI) and investigates its reliability, feasibility, and validity in a sample of Dutch nursing home patients with dementia.

Methods

The present study consisted of three phases: (1) the development of a paratonia assessment instrument (PAI) based on the consensus definition; (2) an investigation of the feasibility of the PAI; and (3) a test of the inter-observer reliability of the tool. In the initial development phase, two researchers, a physical therapist and a nursing home physician independently assessed patients with dementia for the presence of paratonia using the first version of the PAI. In the second phase, after analyzing the results of the initial phase and after making adjustments to the operational criteria for assessment of paratonia, the two researchers assessed a new sample of patients using the adapted PAI. In the third phase, two geriatric physical therapists independently assessed a sub-sample of the second phase participants for the presence of paratonia using written instructions for conducting the PAI. During all phases the assessors were blind to the diagnosis of the type of dementia and to the severity stage of the participants.

PAI

In order to develop an assessment tool, we reformulated the consensus definition into five operational sub-criteria, namely:

- an involuntary variable resistance during passive movement;
- the degree of resistance correlates with the speed of movement (e.g. a low resistance to slow movement and a high resistance to fast movement);
- the degree of resistance is proportional to the amount of force applied;
- there is no clasp-knife phenomenon; and
- the resistance to passive movement is in any direction.

The original version of the PAI demanded that a diagnosis of paratonia could only made if patients fulfilled all five criteria.

In order to enable an immediate diagnosis of paratonia, when developing the PAI we chose to exclude the two longitudinal criteria from the consensus definition, namely "the nature of paratonia may change with progression of the dementing illness" and "paratonia increases with progression of dementia."

The severity of paratonia was assessed using the modified Ashworth scale for paratonia, a five-point scale in which 0 = neither resistance nor assistance to passive movement, 1 = slight resistance during passive movement, 2 = more marked resistance to passive movement, 3 = considerable resistance to passive movement, 4 = severe resistance to passive movement, passive movement is impossible.[19]

Information regarding type and onset of the dementia was obtained from the participants' medical charts. The severity of the dementia was assessed by trained nurses using the Global Deterioration Scale (GDS). The GDS consists of seven levels of cognitive decline in which level 1 = no cognitive decline, level 2 = very mild cognitive decline, level 3 = mild cognitive decline, level 4 = moderate cognitive decline, level 5 = moderately severe cognitive decline, level 6 = severe cognitive decline, and level 7 = very severe cognitive decline.[20]

Patients

All participants were residents or day-care visitors of "de Weerde" nursing home in Eindhoven in the Netherlands, except for 22 participants in the second phase who were residents of "Berkenheuvel" nursing home in Geldrop, 5 kilometers from Eindhoven. In order to participate, patients had to fulfill the dementia criteria posited by the DSM-IV-TR. Written proxy consent by the patients' legal representatives was obtained. Participants who were too sick at the time of the assessment or who refused to collaborate were excluded from the study.

Patients were eligible for inclusion for all phases of this study after admission to a dementia special care unit in a nursing home or upon visiting a day-care center in the Eindhoven region.

Procedures

In order to develop a good understanding of the utility of the assessment tool, we initiated the first and the second phase with a small training sample. This was not the case in the third phase, in which the assessors used written instructions for performing the assessment. During all phases, the presence of paratonia was tested by conducting passive movement of the shoulders, elbows, and hips through flexion and extension while the participant was in a seated position (see Figure 1).

Before starting passive movement, the researchers explained their intentions to the participants. The assessors started with a slow, passive movement of the left arm and moved faster once the participant was accustomed to this movement.

Similarly, the right arm, left leg, and the right leg were assessed. The researchers independently assessed each participant successively and were blind to the results of the other assessor.

Because we anticipated a high prevalence of paratonia in this population, the inter-observer reliability was analyzed with the weighted Cohen's κ. In situations with a high *a priori* chance of agreement, we expected the weighted Cohen's κ to correct for an overestimation of the agreement.[21]

All data were analyzed using SPSS 12.1, and the local ethical committee approved the study.

Figure 1. Assessing paratonia with the PAI by conducting passive movement of the shoulders, elbows and hips in flexion and extension.

Results

In the first phase, 100 of the 135 patients who were contacted via their legal representatives agreed to participate and proxy consent was provided. Of these individuals, eight were too ill to participate and another five refused to collaborate. Thus, a total of 87 patients were included in this part of the study.

The first eight participants were used as a training sample. Therefore, valid data were obtained on 79 participants. Of these 79 participants, 17 were men, 62 were women and the mean age was 84.2 years (range: 67-99 years). Additionally, 54.4% (n = 43) had AD; 17.7% (n = 14) had a combination of AD and vascular dementia (VaD); 21.5% (n = 17) had VaD; and 5.1% (n = 4) had dementia with Lewy bodies (DLB). One patient (1.3%) had dementia with no distinct specification. The majority of the participants suffered from severe to very severe cognitive decline, with 32.9% of the patients rated at GDS level 7 (n = 26), 36.7% at GDS 6 (n = 29), 13.9% at GDS 5 (n = 11), and 16.4% of the participants at GDS 4 (n = 13). Data were collected in 2005 between April and June.

In the second phase, 124 of the 201 patients who were contacted via their legal representatives agreed to participate by providing proxy consent. Of these individuals, three were too ill to participate, eight were not present on the day of the assessment, and 16 refused to collaborate. As a result, 97 participants were included in this phase of the study. Of this sample, the first six subjects and five additional subjects half-way through the assessment were used as a training sample. Therefore, valid data were obtained on 86 subjects. This group comprised 26 men and 60 women with a mean age of 84.35 years (range 65-96 years). Of these participants, 52.3% (n = 45) had AD; 25.6% (n = 22) had VaD; 17.4% (n = 15) had a combination of AD and VaD; and 2.3% (n = 2) had DLB. Two patients (2.3%) had dementia with no distinct specification. Again, the majority of the participants were in the late stages of the disease with 29.1% at GDS 7 (n = 25), 38.4% at GDS 6 (n = 33), 22.1% at GDS 5 (n = 19), 8.1% at GDS 4 (n = 7), and 2.3% at GDS 3 (n = 2). Data were collected in 2006 between June and August. Of the participants in the second assessment, 33% (n = 28) had also participated in the first assessment.

In the third phase, the adjusted assessment tool was tested in a random subsample of 24 participants by two geriatric physical therapists who were blind with respect to all previous results. They assessed four men and 20 women with a mean age of 85.42 (range 78-95). Of these individuals, 54.2% (n = 13) had AD; 25% (n = 6) had VaD; 12.5% (n = 3) had a combination of AD and VaD; and4.2%(n = 1) had DLB. One patient (4.2%) had dementia with no distinct specification. The severity of cognitive decline of these participants ranged from moderately severe to very severe with 29.2% at GDS 5 (n = 7), 37.5% at GDS 6(n = 9), and 33.3% at GDS 7 (n = 8). Data were collected in July 2006.

All participants were native Dutch inhabitants except for one Turkish woman.
Distribution among dementia subtypes was essentially comparable with that seen in the general population (see Table 1).
In phase 1 of this study, the first assessor diagnosed paratonia in 61 (77%) of the participants, and no paratonia in the remaining 18 (23%) participants. The second assessor diagnosed paratonia in 65 (82%) participants, and no paratonia in the remaining 14 (18%) participants. This resulted in an interobserver reliability or Cohen's κ of 0.532.
A qualitative analysis in which both assessors discussed their experiences revealed that the assessors had difficulty interpreting one diagnostic criteria, namely "the degree of paratonia is proportional to the amount of force applied." Both assessors agreed that, in most cases, it was actually the other way around, and that the amount of force applied was necessary to determine the degree of resistance. Furthermore, in discussing cases in which there was a lack of consensus, the assessors discovered that if one felt resistance in two or more directions in one limb or resistance in two or more limbs, a diagnosis of paratonia was made. This was the case in 92.4% of the cases assessed by the first assessor and in 88% of the cases assessed by the second assessor.

Table 1. Demographics and type of dementia of the participants in comparison with the overall dementia population in the Netherlands

Type of dementia	**Participants 1st phase**			**Participants 2nd phase**			**Participants 3rd phase**			Prevalence of type of dementia in Dutch Dementia Population; [22]		
	total	Intern	Day-care	Total	Intern	Day-care	Total	Intern	Day-care			
	79	58	21	86	47 +22*	17	24	24	0			
	Age (range)	Men % (n)	Women% (n)	Age (range)	Men % (n)	Women % (n)	Age (range)	Men% (n)	Women% (n)	Overall %	Men %	Women %
	84.2 (67-99)	21.5% (17)	78.5% (62)	84.35 (65-96)	30% (26)	70% (60)	81.75 (78-95)	20% (4)	80% (20)		23.9%	76.1%
Alzheimer + Alz. and Vasc	72.2% (57)	52.9% (9)	77.4% (48)	69.7% (60)	61.5% (16)	73.3% (44)	66.7% (16)	50% (2)	70% (14)	72%	67.8%	73.7%
Vascular	21.5% (17)	35% (6)	17.7% (11)	25.6% (22)	38.5% (10)	20% (12)	25% (6)	50% (2)	20% (4)	16%	17.9%	15.7%
Lewy Body	5.1% (4)	6% (1)	4.8% (3)	2.3% (2)	0% (0)	3.3% (2)	0% (0)	0% (0)	0% (0)	6%	5.4%	6.7%
Other	1.2% (1)	6% (1)	0% (0)	2.3% (2)	0% (0)	3.3% (2)	4.2% (1)	0% (0)	5% (1)	6%	8.9%	3.9%

* participants from nursing home Berkenheuvel in Geldrop the Netherlands.

Based on these results, we decided to adjust the PAI. We specified the criterion that "resistance must be felt in either one limb in two movement directions or in two different limbs" and removed "the degree of paratonia is proportional to the amount of force applied."
In the second phase, the first assessor diagnosed paratonia in 68 (79%) subjects and no paratonia in the remaining 18 (21%) subjects. The second assessor diagnosed paratonia in 69 (80%) subjects, and no paratonia in the remaining 17 (20%) subjects. This resulted in an inter-observer reliability or Cohen's κ of 0.677.

In the third phase, the first therapist diagnosed paratonia in 20 (83.3%) subjects, and no paratonia in the remaining 4 (16.7%) subjects. The second therapist diagnosed paratonia in 22 (91.7%) subjects, and no paratonia in the remaining 2 (8.3 %) subjects. This resulted in an inter-observer reliability or Cohen's κ of 0.625. The initial two assessors found a paratonia prevalence of 83.3% and 87.5%, respectively, in this sub-sample, which resulted in a Cohen's κ ranging from 0.625 to 1 between the initial assessors and the two physical therapists (see Table 2).
The two geriatric physical therapists received only written instructions on how to use the PAI. After assessing 16 participants, they conferred with one of the developers of the PAI about their experiences. It appeared that both therapists found the written instructions were sufficient.
From all assessments, it became clear that the presence and the severity of paratonia increased with the severity of the dementia. This is illustrated in Table 3 where the percentages of the diagnosed presence and severity of paratonia in the second phase is shown for both assessors.

Table 2. Cohen's Kappa table between initial assessors and two independent physical therapists

	1st assessor	2nd assessor	1st therapist
1st assessor			
2nd assessor	0.677		
1st therapist	1	0.833	
2nd therapist	0.625	0.778	0.625

Table 3. Prevalence and severity of paratonia in the second phase

GDS (number of participants)	Prevalence of paratonia (number of participants)		Severity of paratonia, more than twice the score of 3 or 4 on the Ashworth scale	
	Assessor 1	Assessor 2	Assessor 1	Assessor 2
GDS 4 (n=7)	42,9% (n=3)	28,6% (n=2)	0% (n=0)	0% (n=0)
GDS 5 (n=19)	63,2% (n=12)	63,2% (n=12)	0% (n=0)	16,7% (n=2)
GDS 6 (n=33)	84,8% (n=28)	92,9% (n=31)	28,6% (n=8)	48,4% (n=15)
GDS 7 (n=25)	100% (n=25)	96% (n=24)	96% (n=24)	87,5% (n=21)

Discussion

Based on the new international consensus definition of paratonia, the PAI was developed as a tool to assess the presence of paratonia. The PAI is a construct of five criteria derived from the definition, representing distinct elements of the clinical manifestation of paratonia. The results show that the PAI may be a helpful tool in daily practice and for research into movement disorders in dementia. The PAI enables professionals to distinguish between paratonia, parkinsonian rigidity, and spastic hemiparesis (see Box 1).

- An involuntary variable resistance during passive movement
- There is no clasp-knife phenomenon
- The resistance to passive movement is in any direction
- Resistance must be felt in either one limb in two movement directions or in two different limbs
- The degree of resistance correlates with the speed of movement (e.g. a low resistance to slow movement and a high resistance to fast movement)

Box 1. Paratonia Assessment Instrument (PAI).

Validity

Because the PAI is based on expert consensus definition, a high content validity is ensured. Criterion validity could not be established because there is no gold standard for diagnosing paratonia. Therefore, the PAI could not be compared with other instruments. The original five criteria were adjusted after the first phase. Specifically, we removed the criterion that "the degree of paratonia is proportional to the amount of force applied" because both assessors had difficulties interpreting this in practice. Furthermore, a newly formulated criterion was added after a qualitative analysis. This criterion was "resistance must be felt in either one limb in two movement directions or in two different limbs." It is our understanding that using this new criterion in the second and third phase of our study allowed for a better differentiation

between paratonia and spastic hemiparesis, thereby enhancing the construct validity of the tool. Prior to adding this criterion, the only criterion for this differentiation was the presence or absence of a clasp-knife phenomenon. Spasticity after stroke is usually presented as a flexor spasm or extensor spasm, so resistance is expected to be felt in only one direction during passive movement. In paratonia, resistance can be felt in both directions.

A limitation of the construct was found in the criterion "the degree of resistance correlates with the speed of movement (e.g. a low resistance to slow movement and a high resistance to fast movement)." Increasing the speed of movement proved to be very difficult in patients with late stage dementia, as the resistance was already very high with slow movement. This hampered the differentiation between paratonia and parkinsonian (lead pipe) rigidity. As a result, we contend that this criterion is only valid if increasing speed of movement is still possible, which is the case when the resistance felt during slow movement is lower than 3 on the Modified Ashworth scale in at least one of the limbs.

Therefore, the rule that all five criteria must be met in order to diagnose paratonia is not applicable in the most severe cases.

A further limitation of the construct was found when using the PAI with participants who differ in their ability to relax or who experience variable difficulty in adjusting to the speed of movement. This was mostly the case in participants with mild to moderate cognitive decline. Because the resistance felt was often very swift, it was very difficult to diagnose paratonia in these participants.

A longitudinal study with participants in the early stages of dementia may generate more insight regarding possible markers for paratonia or the sub-clinical signs of paratonia. This kind of research may serve to enhance our understanding of the PAI construct.

The results show a clear relationship between the severity of cognitive decline and the presence and severity of paratonia. Most of the participants with very severe cognitive decline were diagnosed by both assessors as having very severe paratonia, while the majority of the participants with mild to moderate cognitive decline had no paratonia and, if they had paratonia, it was not severe. This can be interpreted as a validation of the longitudinal criteria in the consensus definition where it was stated that "the nature of paratonia may change with progression of the dementing illness" and "paratonia increases with progression of dementia."

Reliability

The inter-observer reliability was calculated for all phases of the study using the weighted Cohen's κ. The ratings of Cohen's κ were valued as follows: 0.21-0.40 represents fair agreement, 0.41-0.60 reflects moderate agreement, 0.61-0.80 demonstrates substantial agreement, and >0.80 is considered to reflect a high level of agreement (Feinstein, 2002).

The inter-observer reliability of the PAI improved substantially from a Cohen's κ of 0.532 in the initial phase to 0.677 in the second phase. The adjustments made on the original PAI construct were necessary to reach this level of substantial agreement. The perceived improvement of the inter-observer reliability was supported by the data from the third phase of the study, in which a small sample of 24 patients assessed by two independent assessors showed that agreement varied from substantial (0.625) to high (1).
A limitation of this study is the modest sample sizes in the first two phases and the relatively small sub-sample in the third phase that comprised only participants with moderately severe to very severe cognitive decline. A further limitation is the fact that although the assessors were blind to the diagnosis and severity of the dementia, the severity would be at least apparent to them during the assessments which could lead to diagnostic suspicion bias.
So although Cohen's κ between all four assessors provides us with a reasonably consistent picture of a reliable tool, research using a larger population might improve this result.

Feasibility

All assessors, namely three physical therapists and one nursing home physician, were positive about the use of the PAI in daily practice. They indicated the need to allow approximately ten minutes per patient to establish the presence of paratonia. Furthermore, the PAI is of no obvious burden to the patient and it can be easily integrated into a normal physical examination. Written instruction on how to perform the PAI appeared to be sufficient for professionals to become accustomed to using it. Further research maybe necessary to investigate the applicability of this tool for examiners other than those involved in this study, yet we believe that it is feasible for all examiners with experience in physical examination to use it.

Conclusion

Following the adjustments made after the initial phase, inter-observer reliability improved to a high standard. The results of this study suggest that the PAI is a reliable and valid tool for diagnosing paratonia in the demented elderly.
This assessment tool is easy to use in daily practice and makes possible further investigations into, for example, treatment strategies for paratonia. It can also be a starting point for further recognition of the importance of differences of movement disorders in different types of dementia and therefore eventually of incorporated these into a tool for differential diagnosis.

Conflict of interest

None.

Description of authors' roles

Hans Hobbelen designed the study, collected and analyzed the data, and wrote the manuscript. Raymond Koopmans supervised the study and data collection and assisted in the writing of the paper. Frans Verhey helped to design the study and write the paper. Kitty Habraken assisted with the design of the study, the collection of data, and the analyses of the data. Rob de Bie was responsible for the epidemiological aspects of the study and also supervised the data analyses and helped write the paper.

Acknowledgments

We thank the Vitalis WoonZorg Group in Eindhoven, the Netherlands, who provided a grant to support this study. We thank all participants and personnel at the nursing home "de Weerde," which is part of the Vitalis care group in Eindhoven, and the nursing home "Berkenheuvel," which is part of the Anna Care Group in Geldrop. Additionally, we thank Frederike Stevens and Greetje Schoots for their contribution to the assessments in the third phase of this study.

References

1. Galasko, D., Kwo-on-Yuen, P. F., Klauber, M. R. and Thal, L. J. (1990). **Neurological findings in Alzheimerís disease and normal aging.** Archives of Neurology, 47, 625-627.
2. Selkoe, D. J. (1992). **Aging brain, aging mind.** Scientific American, 267, 134-142.
3. Funkenstein, H. H. et al. (1993). **Extrapyramidal signs and other neurologic findings in clinically diagnosed Alzheimerís disease: a community-based study.** Archives of Neurology, 50, 51-56.
4. O'Keeffe, S. T., Kazeem, H., Philpott, R. M., Playfer, J. R., Gosney, M. and Lye, M. (1996). **Gait disturbance in Alzheimerís disease: a clinical study.** Age and Ageing, 25, 313-316.
5. Kurlan, R., Richard, I. H., Papka, M. and Marshall, F. (2000). **Movement disorders in Alzheimerís disease: more rigidity of definitions is needed.** Movement Disorders, 15, 24-29.
6. Dupré, E. (1910). **Débilité mentale et débilité motrice associées.** Revue Neurologique, 20, 54-56 (in French).
7. Franssen, E. H., Kluger, A., Torossian, C. L. and Reisberg, B. (1993). **The neurologic syndrome of severe Alzheimerís disease: relationship to functional decline.** Archives of Neurology, 50, 1029-1039.
8. Souren, L. E., Franssen, E. H. and Reisberg, B. (1997). **Neuromotor changes in Alzheimer's disease: implications for patient care.** Journal of Geriatric Psychiatry and Neurology, 10, 93-98.
9. Gladstone, D. J. and Black, S. E. (2002). **The neurological examination in aging, dementia and cerebrovascular disease.** Part 2: Motor examination. Geriatrics and Aging, 5, 44-49.
10. Bennett, H. P., Corbett, A. J., Gaden, S., Grayson, D. A., Kril, J. J. and Broe, G. A. (2002). **Subcortical vascular disease and functional decline: a 6-year predictor study.** Journal of the American Geriatrics Society, 50, 1969-1977.
11. Van de Rakt, J. (1997). **The development of a fetal posisition in psychogeriatric patients: a hypothesis.** Fysiotherapie en ouderenzorg, June, 2-6 (in Dutch).
12. Kleist, K. (1927). **Gegenhalten (motorischer negativismus) Zwangsgreifen und Thalamus Opticus.** Monatsschrift für Psychiatrie und Neurologie, 65, 317-396 (in German).
13. Paulson, G. and Gottlieb, G. (1968). **Development reflexes: the reappearance of foetal and neonatal reflexes in aged patients.** Brain, 91, 37-52.
14. Middelveld-Jacobs, I. and Van Den Boogerd, M. (1986). **Paratonia, a form of hypertonia in a nursing home population.** Nederlands Tijdschrift voor Fysiotherapie, 96, 85-87 (in Dutch).
15. Tyrrell, P. and Rossor, M. (1988). **The association of gegenhalten in the upper limbs with dyspraxia.** Journal of Neurology, Neurosurgery and Psychiatry, 51, 995-997.
16. Beversdorf, D. Q. and Heilman, K. M. (1998). **Facilitory paratonia and frontal lobe functioning.** Neurology, 51, 968-971.
17. Hobbelen,J.S., Koopmans,R.T., Verhey,F.R., VanPeppen, R. P. anddeBie,R.A. (2006). **Paratonia: a delphi procedure for consensus definition.** Journal of Geriatric Physical Therapy, 29, 50-56.
18. Lance, J. W. (1980). **Symposium synopsis.** In R. G. Feldman, R. R. Young and W. P. Koella (eds.), Spasticity: Disordered Motor Control. Chicago: Year Book Medical Publishers.
19. Waardenburg, H., Elvers, W., Van Vechgel, F. and Oostendorp, R. (1999). **Can paratonia be measured reliably? Evaluation of the reliability of a visual analogue scale and the modified tonus scale of Ashworth for measuring paratonia.** Nederlands Tijdschrift voor Fysiotherapie, 102, 30-35 (in Dutch).

20. Reisberg, B., Ferris, S. H., de Leon, M. J. and Crook, T. (1982). **The Global Deterioration Scale for assessment of primary degenerative dementia.** American Journal of Psychiatry, 139, 1136-1139.

21. Streiner,D.L.and Norman,G.R. (2003). **Health Measurement Scales: A Practical Guide to their Development and Use.** New York: Oxford University Press.

22. Ott, A. et al. (1995). **Prevalence of Alzheimerís disease and vascular dementia: association with education.** The Rotterdam study. BMJ, 310, 970-973.

23. Feinstein, A. R. (2002). **Principles of Medical Statistics.** New Haven, CT: Chapman and Hall/CRC Press.

5

Prevalence, incidence and risk factors of paratonia in patients with dementia; a 1-year follow-up study

Authors:
Hans Hobbelen
Frans Tan
Frans Verhey
Raymond Koopmans
Rob de Bie

Submitted

Abstract

Objectives:
Explore possible contributing factors and indicators of the development of paratonia in dementia.

Design:
A multi-centre longitudinal 1-year follow-up cohort study.

Setting:
Dementia day-care centres with dementia special care units (DCUs) in the regions Eindhoven, Helmond and Tilburg in the Netherlands.

Participants:
Fit and mobile persons with dementia were considered eligible for inclusion. Participants were only included after written informed or proxy consent.

Measurements:
Participants were assessed with the Paratonia Assessment Instrument (PAI), Timed Up and GO (TUG; functional mobility), Qualidem (quality of life), Global Deterioration Scale of Reisberg (GDS; severity of dementia), Mini Mental State Examination (MMSE; cognitive function) and diagnosis of dementia, co-morbidities and use of medication were obtained from the participants' medical dossier. The PAI was assessed every 3 months. All other variables were assessed at baseline and after 12 months.

Results:
Baseline measures were assessed in 204 participants, 111 (54%) female and 93 (46%) male with a mean age of 79.8 years (56-97). Seventy-one (34.8%) were diagnosed with paratonia at baseline and 51 developed paratonia over one year. In the Vascular Dementia group the highest Hazard ratio (3.1) for developing paratonia in 1-year's time was found and one of the highest prevalences at baseline (42%).
Logistic regression analysis revealed that one unit lower on the MMSE (OR= .90) and Diabetes Mellitus (OR=10.7) were significantly related to the development of paratonia (Wald chi square p-value <.01).

Conclusion:
DM is a significant risk factor for the development of paratonia as well as probably vascular damage.

Background

Alzheimer's disease (AD), Dementia with Lewy Bodies (DLB) and Vascular Dementia (VaD) are the most common causes of dementia. In addition to cognitive decline, accompanying motor dysfunctions, such as slowness, rigidity, impaired balance and gait, are frequently reported in these disorders.[1-5] The development of motor disturbances varies within and between the types of dementia.[6-10] In AD, motor decline is not predominant in the early stages, while in DLB and VaD distinct movement disorders can be present at onset. Especially in the late stages of AD, DLB and VaD movement disorders become more obvious with a gradual decline of motor control that often progresses into a total immobilization of the patient.[11-13]

Paratonia, a form of hypertonia or an active unintentional resistance against passive movement, is a motor problem frequently seen in individuals with dementia, and results in loss of mobility and the development of contractures.[13-15] One of the earliest signs of the development of paratonia was reported by Beversdorf et al., who noticed the inability to relax during a passive movement applied by an examiner in 44% (n=11) of mild dementia cases.[16] The prevalence of paratonia increases with progression of dementia and is estimated to be 100% in later stages.[13]The effect of paratonia on patients' quality of life is devastating and the carer's burden increases substantially during the years. [13]

Several authors suggest that paratonia can develop in AD as well as in VaD and DLB, and even in not cognitively impaired elderly.[17-23] It has also been suggested that patients with paratonia represent a specific subtype of AD with a more rapid decline. [8, 18] Paratonia has been associated in early stage dementia with the development of apraxia and in late stage dementia with the reappearance of neonatal reflexes known as frontal release symptoms. [12, 14, 16, 24-28]

The pathogenesis of paratonia is not well understood. The increased prevalence in patients with neurodegenerative disorders suggests a central cerebral pathology, possibly substantia nigra pathology, [8, 18, 21] but PET scan analyses and autopsy studies found no evidence for dopaminergic nigrostriatal dysfunction in AD patients with paratonia. [26]Alternatively, peripheral biomechanical changes have been hypothesized[29] , since increased stiffness of muscle fibres and loss of sarcomeres have been found in hypertonia in stroke and cerebral palsy patients,[30, 31] and changes in the biomechanical properties i.e. in collagen tissue and tendons may also contribute in the development of paratonia.[29, 32] Earlier research reported diabetes mellitus (DM) and general multimorbidity as a risk factor for muscle rigidity.[33, 34] [22] In addition anti-psychotic medication may induce paratonia-like rigidity in dementia.[21, 35]

Until now most studies on paratonia focussed on patients in late stage of dementia with severe paratonia, making it difficult to investigate retrospectively which factors contributed to the development of paratonia. To date, no longitudinal studies exist that examine contributing factors in the development of paratonia.

The interpretation of the results of previous studies on paratonia is hampered by a lack of a generally accepted definition of paratonia. In line with this, preventive interventions, targeted especially to subdue the negative effects of paratonia in the course of dementia, are not yet available. Recently, a consensus definition was established, and new valid and reliable assessment instrument for paratonia became available, stimulating new research in this field.[15, 36]

We performed a 1-year longitudinal study among Dementia day-care visitors in order to explore possible contributing factors to and indicators for the development of paratonia in dementia.

The specific research questions were the following: 1) Are there differences in the profile of participants with and without paratonia? 2) In what stage of dementia does paratonia develop? 3) Are there differences in the course and development of paratonia between the different types of dementia? 4) Is a decreased functional mobility an early indicator for the development of paratonia? and 5) Do Diabetes Mellitus, multimorbidity or the use of antipsychotic medication contribute to the development of paratonia?

Methods

Design: a multi-centre longitudinal 1-year follow-up cohort study. Every three months the participants were visited in their own centre.

Study population: Dementia day-care centres of nursing homes and residential homes with dementia special care units (DCUs) in the regions Eindhoven, Helmond and Tilburg in the Netherlands were selected as recruitment facilities. Persons were considered eligible for inclusion when they: 1) had an established diagnosis of dementia according to the Diagnostic Statistical Manual IV-TR criteria,[37] 2) scored stage 6 or lower on the Global Deterioration Scale of Reisberg (GDS)[38], and 3) were able to walk at least 10 metres without assistance (a walking aid was allowed), which was necessary for the assessment of the functional mobility. Participants were excluded when they were in bad clinical condition. Personnel of the participating day-care centres and DCUs were asked to identify eligible participants, after which an information brochure about the study and an application form for written consent was sent to the person and their legal representative. Participants were only included after written informed consent by the representative. When included, the patients' General Practitioner (GP) was notified about study participation. Participants who initially agreed to participate yet refused further collaboration during the study were excluded. The local ethical committee of the region Arnhem/Nijmegen, the Netherlands, approved the study.

Assessments:

Primary outcome measure is the Paratonia Assessment Instrument (PAI) [36]

The PAI is an assessment instrument by which an examiner can establish the presence of paratonia by moving successively all four limbs passively in flexion and extension with the participant in a sitting position. [36]The examiner starts with a slow movement of the limb after which the movement is accelerated. Paratonia was diagnosed when all 5 criteria of the PAI were fulfilled: 1) there is an involuntary variable resistance; 2) the degree of resistance varies depending on the speed of movement (e.g. a low resistance by slow movement and a high resistance by fast movement; 3) the resistance to passive movement can be in any direction; 4) there is no clasp-knife phenomenon; and 5) the resistance is felt in 2 movement directions in 1 limb or in 2 different limbs.

Baseline variables:

1. Functional mobility was assessed with the Timed up and Go test (TUG). [39] The TUG measures time in seconds to stand up from a chair (approximate height of 46 cm) walk 3 metres, turn around a cone, walk back to the chair and sit down. A score of 20 seconds or more is associated with a higher risk for falling.
2. Quality of life was assessed with the Qualidem. [40] This is a 40-item caregiver rated assessment especially developed for residential care. The maximum score is 120 indicating a high quality of life.
3. Severity of dementia was classified with the 7-point Global Deterioration Scale of Reisberg (GDS). The GDS rates cognitive deterioration in dementia, from normal cognition (stage one) to very severe cognitive decline (stage seven).[38] We considered GDS 3 and 4 as mild dementia, GDS 5 as moderate and GDS 6 as severe dementia.
4. Cognitive function was tested with the Mini Mental State Examination (MMSE). [38] The MMSE is an 11-item questionnaire with a maximum score of 30 indicating no cognitive decline and a minimum score of 0 indicating very severe cognitive decline.
5. The diagnosis of dementia, all co-morbidities and the use of medication were obtained from the participants' medical dossier combined with the GP files. The co-morbidities have been classified according to the Dutch classification of diseases in nursing home care. Medication was classified according to the international Anatomic Therapeutic Chemical (ATC) classification system [41]

One experienced and well-trained assessor administering the PAI, the TUG and the MMSE assessed all patients. Trained personnel of the participating day-care centres assessed the participants with the Qualidem and the GDS.

The PAI was assessed every 3 months from baseline onwards. All other variables were assessed at baseline and after 12 months.

Analysis:
Data has been analysed with SPSS 16.0 for Macintosh. With an expected prevalence of paratonia of 25% in this population and an estimated one-year incidence of 25% and six key factors that possibly influence the development of paratonia (e.g., age, medication, severity of the dementia, type of dementia, functional mobility and co-morbidities), sample-size calculations indicated that approximately 240 participants would be needed to study the development of paratonia (taking into account 10 participants per factor).

To analyse the subsequent research questions, we first describe the baseline characteristics and analyse the different determinants of paratonia in the baseline cohort with independent sample t-tests or cross-tabulation chi-square. Secondly, a paratonia-free cohort at baseline was studied to establish the hazard ratio between the different GDS stages and the different types of dementia. For this we performed a Cox regression with the PAI as dependent variable at the subsequent time intervals of three months, the total number of days in the study as time variable, and the GDS and type of dementia as independent variable in two separate analyses. Furthermore, we described the characteristics at baseline and after one year of those participants who develop paratonia in a year's time and completed the study. Finally we analysed the risk factors for paratonia with logistic regression with the PAI after 12 months as dependent variable with the following baseline independent variables: age, gender, MMSE, TUG, total amount of co-morbidities, diabetes mellitus, Stroke/TIA, total amount of medication, antipsychotic medication and type of dementia. In this logistic regression analysis we have also discarded data from those participants with paratonia at baseline.
For all analyses we consider p-values < .05 as statistically significant.

Results

Out of 366 eligible participants 210 (57.4%) agreed to participate. Four participants were excluded due to severe illness, resulting in 206 participants being included. Over one-year 59 participants were lost to follow-up, two before baseline measures started due to withdrawal of informed consent, 41 died (cause of death not noted) and 16 were transferred to unknown address or became severely ill. See figure 1.

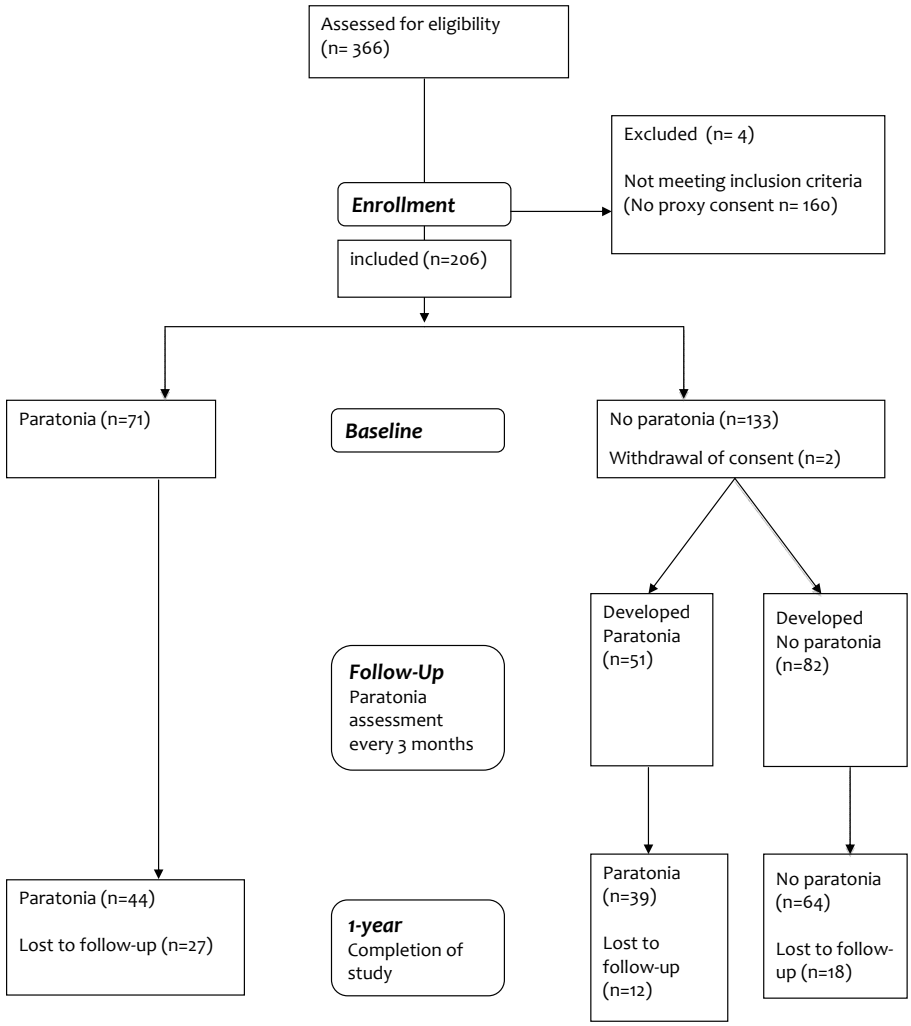

Figure 1. Study flow chart

Most participants had AD (44.6%, n=91), VaD (24.5%, n=50) or mixed dementia (VaD and AD) (17.6%, n=36).

Baseline measures were assessed in 204 participants, 111 (54.4%) females and 93 (45.6%) males, with a mean age of 79.8 years (56-97). See table 1.

Table 1. Baseline characteristics

Participants n (%)	Paratonia	No Paratonia	Total, n
	71 (34.8%)	133 (65.2%)	204 (100%)
Male n (%)	32 (45.1%)	61 (45.9%)	93 (45.6%)
Female n (%)	39 (54.9%)	72 (54.1%)	111 (54.4%)
Age, mean (sd)	79.2 (7.1)	80.1 (7.7)	79.8 (7.5)
Diagnosis type of dementia n (%) ;			
AD	27 (38%)	64 (48.1%)	91 (44.6%)
VaD	21 (29.6%)	29 (22.8%)	50 (24%)
Mixed AD + VaD	16 (22.5%)	20 (15%)	36 (17.6%)
LBD	5 (7%)	9 (6.8%)	14 (6.9%)
Different aetiologies	2 (2.8%)	11 (8.3%)	13 (6.4%)
Co-morbidities, Median (range)	4 (0-7)	4 (0-9)	4 (0-9)
Diabetes Mellitus n (%)†	17 (23.9%)	21 (15.8%)	38 (18.6%)
Stroke-TIA n (%)†	29 (40.8%)	37 (27.9%)	66 (32.4%)
Use of medicines, Median (range)	4 (0-11)	5 (0-16)	5 (0-16)
Anti-psychotic drugs n (%)†	12 (16.9%)	23 (17.4%)	35 (17.2%)
NSAIDS n (%)†	4 (5.6%)	5 (3.8%)	9 (4.4%)
TUG > 20 sec n (%)†	35 (49.3%) *	27 (20.3%)	62 (30.4%)
Qualidem, Mean (sd)‡	91.4 (15.3)	94.5 (14.6)	93.4 (14.9)
MMSE, Mean (sd)§	15.5 (6.4) *	18.2 (6.6)	17.3 (6.7)
GDS, Median (range)¶	5 (3-6) *	4 (3-6)	4 (3-6)
GDS 3 + 4	28(39.4%)	83 (62.4%)	111 (54.4%)
GDS 5	36 (50.7%)	45 (33.8%)	81 (39.7%)
GDS 6	7 (9.9%)	5 (3.8%)	12 (5.9%)

* = p-value <.01

†The variables Diabetes Mellitus, Stroke/Tia, antipsychotic drugs, NSAIDS and Timed Up and Go (TUG) > 20s are dichotomous.
‡Qualidem score range 0-120; higher score indicates a higher quality of life.
§Mini Mental State Examination(MMSE) score range 0-30, score 24-28 indicates: very mild; 19-23: mild; 14-18 moderately severe; <14 severe cognitive decline.
¶Global Deterioration Scale (GDS) stages range 1) normal cognition to 7) very severe cognitive decline.

Baseline characteristics

Paratonia was diagnosed in 71 patients (34.8%) at baseline. The prevalence of paratonia was highest in patients with mixed dementia (44.4%, 16 out of 36) and in the VaD group (42%, 21 out of 50), yet compared with AD (29.7%, 27 out of 91) this was not statistically significant. The prevalence of paratonia increased significantly in more severe dementia: 25.2% (28 out of 111) in patients with mild dementia (GDS 3 and 4), 44.4% (36 out of 81) in moderate dementia (GDS 5) and 58.3% (7 out of 12) in severe dementia (GDS 6), (Cross tabulation chi-square $p < .01$).

Patients with paratonia had in general higher GDS rating (chi-square, p<.01), lower MMSE scores (scores: 15.4 versus 18.2; independent sample t-test p < .01) and worse TUG (Cross tabulation chi-square p< .01).

Longitudinal data

One hundred and forty-seven participants completed the study. Of the 71 diagnosed with paratonia at baseline 27 were lost to follow up. The remaining 44 were again diagnosed with paratonia after one year.

Out of the 133 participants who did not have paratonia at baseline, 51 participants (38.3%) were diagnosed in the course of one year with paratonia of which 39 completed the study and 12 were lost to follow-up. Of the remaining 82 participants who were not diagnosed with paratonia, 64 completed the study and 18 were lost to follow-up.

Patients without complete follow-up did not differ from those who completed the study with regard to age, gender and severity of dementia.

Between the different types of dementia VaD participants have the highest hazard ratio to develop paratonia (HR=3.07, 95% CI .7-14.1, not significant) with LBD as reference. The hazard ratio between the different stages of dementia, with mild dementia as reference was significant indicating that the incidence increases with increasing severity of dementia (severe versus mild dementia: HR=5.34, 95% CI 1.82-15.6). In table 2 the hazard ratio of the different types of dementia and the different stages are shown.

Table 2. Cox regression with the PAI as dependent variable and the independent variables type and stage of dementia (analysed separately).

variable	ß	SD	Exp (ß)*	95% CI
Type of dementia:				
LBD	reference			
AD	.93	.76	2.54	.57-11.2
VaD	1.12	.78	3.1	.67-14.1
mixed	.71	.79	2.03	.43-9.5
other	.15	1.02	1.16	.16-8.6
Stage of dementia				
Mild (GDS‡ 3+4)	reference			
Moderate (GDS5)	.45	.29	1.57	.88-2.79
Severe (GDS 6)	1.67	.55	5.34	1.82-15.6†

*Exp (ß)= Hazard ratio
†p-value <0.05
‡ Global Deterioration Scale (GDS)

The baseline characteristics of the 39 incident cases of paratonia in comparison with the baseline characteristics of the 64 participants who did not develop paratonia and completed the study are outlined in table 3.

Table 3. Participants characteristics developing paratonia in 1-year's time in comparison with paratonia-free participants.

	Baseline characteristics		Characteristics after 1 year	
Participants n (%)	Paratonia after 1 year	No Paratonia	Paratonia	No paratonia
	39 (37.9%)	64 (62.1%)	39 (37.9%)	64 (62.1%)
Male	17 (43.6%)	28 (43.8%)		
Female	22 (56.4%)	36 (56.2%)		
Age (sd)	82.4(7.2)	78 (8.2)		
Diagnosis type of dementia;				
AD	15 (38.5%)	31 (48.4%)		
VaD	11 (28.2%)	13 (20.3%)		
Mixed AD + VaD	9 (23.1%)	8 (12.5%)		
LBD	2 (5.1%)	5 (7.8%)		
Different aetiologies	2 (5.1%)	7 (10.9%)		
Co-morbidities	4 (0-9)	3 (0-9)	5 (0-11)	3 (0-9)
Diabetes Mellitus†	11 (28.2%)	5 (7.8%)**	11 (28.2%)	5 (7.8%)*
Stroke-TIA†	14 (35.9%)	20 (31.3%)	14 (35.9%)	20 (31.3%)
Use of medicines	5 (0-14)	5 (0-10)	5 (2-15)	5 (0-9)
Anti-psychotic drugs†	8 (20.5%)	9 (14.1%)	15 (38.5%)	13 (20.3%)
NSAIDS†	1 (2.6%)	1 (1.6%)	2 (5.1%)	1 (1.6%)
TUG > 20 sec†	9 (23.1%)	7 (10.9%)	22 (56.4%)	8 (12.5%) *
Qualidem‡	93.4 (12.7)	96.7 (15.2)	87 (14.3)	90.9 (16.6)
MMSE§	17 (7.4)	20 (5)**	13.5 (7.6)	18.7 (6.1)*
GDS¶	4 (3-6)	5 (3-6)	5(3-6)	5(3-6)
GDS 3+4	20 (51.3%)	45 (70.3%)	6 (15.4%)	28 (43.8%)
GDS 5	18 (46.2%)	19 (29.7%)	18 (46.2%)	26 (40.6%)
GDS 6	1 (2.5%)	0 (0%)	13 (33.3%)	8 (12.5%)

***** p-value <.01

†The variables Diabetes Mellitus, Stroke/Tia, antipsychotic drugs, NSAIDS and Timed Up and Go (TUG) > 20s are dichotomous.

‡Qualidem score range 0-120; higher score indicates a higher quality of life.

§Mini Mental State Examination(MMSE) score range 0-30, score 24-28 indicates: very mild; 19-23: mild; 14-18 moderately severe; <14 severe cognitive decline.

¶Global Deterioration Scale (GDS) stages range 1) normal cognition to 7) very severe cognitive decline.

Baseline scores and 1-year rate of decline in both the MMSE, and the TUG were worse in patients who developed paratonia compared with those who did not (MMSE: a mean decline of 3.5 points in the paratonia group and 1.3 in the non-paratonia group; p <.01).
Logistic regression on the longitudinal data indicated that one unit lower on the MMSE scores (OR=.90; 95% CI= .83-.98), and the presence of diabetes mellitus (OR=10.7; 95% CI=2.2-51.7) were the only two significant risk factors to develop paratonia in a year's time. Other co-morbidity and use of antipsychotics or more medication were not related to increased prevalence of incidence of paratonia. See Table 4

Table 4. logistic regression with baseline data of those participants with no paratonia at baseline

Variable*	ß	SD	Exp (ß)	95% CI
Age	.072	.04	1.08	.99-1.16
Gender	-1.0	.58	.37	.12-1.13
MMSE†	**-.10**	**.04**	**.90**	**.83-.98**
TUG	.64	.69	1.9	.49-7.32
Co-morbidities	-.07	.14	.93	.71-1.21
Diabetes‡	**2.37**	**.81**	**10.66**	**2.2-51.7**
Stroke-TIA	.01	.47	1.01	.4-2.52
medication	.07	.1	1.08	.89-1.3
Antipsychotics	.28	.71	1.32	.33-5.32
AD +VaD				
AD	-.23	.7	.8	.2-3.2
LBD	-.81	1.2	.45	.04-4.7
VaD	.38	.79	1.5	.31-6.9
other	-.54	1.2	.58	.06-5.7
Intercept	-3.34	3.4	.04	

*Dependent variable: Paratonia Assessment Instrument (PAI); the presence of paratonia No-Yes after one year
Model: (Intercept), Age, Gender, Mini Mental State Examination (MMSE), Timed Up and Go (TUG), total amount of co-morbidities, Diabetes Mellitus, Stroke-TIA, total amount of medication, antipsychotics, Type of dementia (AD+VaD reference group).
†p-value < .05
‡p-value <.01

Discussion

In general the prevalence (34.8%) and incidence (38.3%) of paratonia in this cohort was very high. A higher GDS rating, lower MMSE scores and worse functional mobility is the profile of participants with paratonia. This study confirms that the risk to develop paratonia increases with progression of dementia and decrease of cognitive abilities. [13] Paratonia can already be present in mild dementia, yet the hazard ratio is the highest in those with severe dementia.

There is an indication that patients with VaD or mixed dementia (VaD and AD) are more likely to develop paratonia than patients with other types of dementia; however, these differences were not significant. A decreased functional mobility, indicated by the TUG, is not an early indicator for the development of paratonia and Diabetes mellitus is a significant risk factor for developing paratonia.

The most striking result is our finding that participants with DM have almost an 11-fold higher risk to develop paratonia. DM was not a statistically significant variable in our cross-sectional analyses at baseline. This can be explained by the obvious disadvantage of cross-sectional analyses by which those who are prone to develop paratonia are also present in the data masking the importance of this particular factor. The 95% CI is very broad indicating that the uncertainty of the true OR is high, which is probably caused by the relative small group of 39 participants with paratonia in this analysis.
Nevertheless, DM appeared to be a factor of importance in the development of paratonia. It was already known that DM is associated with a variety of complications and an increased risk for dementia itself.[42] Recent findings suggest that there are different patterns of cerebral injury in dementia with or without DM showing microvascular infarcts and activation of neuroinflammation in individuals with dementia and DM. [43] Moreover, studies by Arvanitakis et al. showed that DM causes rigidity and gait disturbance in older persons without dementia. [22, 44] They suggested that, besides possible damage in the nigro-striatal system and/or white matter changes, DM also causes damage of the peripheral nervous system. Furthermore, it is known that high levels of glucose cause nonenzymatic glycation with advanced glycation endproducts (AGE) forming cross links in collagen that causes stiffening of all tissues, a process normally seen in ageing yet accelerated by DM.[45] We have to acknowledge that there is a possibility that the PAI is not able to distinguish between this stiffness and mild paratonia resulting in an overestimation of the importance of DM as risk factor. Further longitudinal research, with a longer follow-up period, is necessary to unravel the contribution of DM to the development of paratonia. This is especially interesting because it is clear that the negative long-term effects of DM can be influenced by various preventive interventions; particularly an increase of physical activity has proven to be very effective. [46, 47]

Paratonia is seen in all types of dementia. The higher prevalence of paratonia and the higher hazard ratio in the VaD and mix-group of AD and VaD are an indication that vascular damage, alongside dementia, most likely plays an important role in the development of paratonia. Further fundamental research is recommended to reveal the pathways by which vascular damage can possibly contribute to the development of paratonia.

A decline of functional mobility appears to be a good indicator for the presence of paratonia in patients with dementia. However, there is no indication that a decline of functional mobility

can predict the development of paratonia in a year's time. The hypothesis that paratonia is enhanced by changes in the biomechanical properties equivalent with those seen in stroke and cerebral palsy patients is therefore not proven. Paratonia itself seems to be a cause of the decline of functional mobility. However, being the result of a cross-sectional analysis, this should be interpreted with caution.

Limitations

A limitation of this study was the difficulty we encountered in retrieving the medical dossiers from the participants' GPs. Although all participants provided written (proxy) consent, GPs were very reluctant to share information and in some cases we only received information from the dossiers available at the DCUs. It cannot be ruled out that this caused some bias.

We did not fully reach our goal of 240 participants and we realize that the power of our analyses is probably low.

Furthermore, the study cohort was heterogeneous with participants ranging from mild to severe dementia and with different types of dementia. Some selection bias may also have occurred, especially in the mild dementia cases because we recruited participants for this study in DCUs. It can be hypothesized that only mild dementia patients are offered DCU treatment that have a more problematic disease course.

Besides this, a follow-up time of 1 year is short, taking into account that most types of dementia progress in 5 to 10 years. Further longitudinal research for a longer period with larger cohorts is therefore recommended to verify our conclusions.

Conclusion

A decline of the functional mobility is a good indicator for the presence of paratonia in dementia.

DM is a risk factor for the development of paratonia, as well as probably vascular damage. This finding enables us to look further into the possible pathogenesis of paratonia. Furthermore it is a pretext for preventive interventions.

Acknowledgement

We thank all participants and their relatives for their cooperation in this study. We thank all participating DCUs and day care centres from the ' de Zorgboog' Helmond, 'SVVE' Eindhoven, 'de Wever' Tilburg and 'Vitalis WoonZorg Groep' Eindhoven in the Netherlands. Furthermore, we thank all GPs and personnel who actively contributed to this study. We thank Sytse Zuidema, senior scientist of the Department of Primary and Community Care, Centre for Family Medicine, Geriatric Care and Public Health, Radboud University Nijmegen Medical Centre, Nijmegen, the Netherlands, for his enthusiastic and insightful contribution to the analyses of this study, and finally Bob Wilkinson from the Maastricht University Translation and Editing Department.

References

1. Allan LM, Ballard CG, Burn DJ, Kenny RA. **Prevalence and severity of gait disorders in Alzheimer's and non-Alzheimer's dementias.** J Am Geriatr Soc. 2005;53: 1681-1687.
2. Camicioli R, Howieson D, Oken B, Sexton G, Kaye J. **Motor slowing precedes cognitive impairment in the oldest old.** Neurology. 1998;50: 1496-1498.
3. Kurlan R, Richard IH, Papka M, Marshall F. **Movement disorders in Alzheimer's disease: more rigidity of definitions is needed.** Mov Disord. 2000;15: 24-29.
4. Prehogan A, Cohen CI. **Motor dysfunction in dementias.** Geriatrics. 2004;59: 53-54, 56, 59-60.
5. Scherder E, Eggermont L, Swaab D, et al. **Gait in ageing and associated dementias; its relationship with cognition.** Neurosci Biobehav Rev. 2007;31: 485-497.
6. Funkenstein HH, Albert MS, Cook NR, et al. **Extrapyramidal signs and other neurologic findings in clinically diagnosed Alzheimer's disease.** A community-based study. Arch Neurol. 1993;50: 51-56.
7. Galasko D, Kwo-on-Yuen PF, Klauber MR, Thal LJ. **Neurological findings in Alzheimer's disease and normal aging.** Arch Neurol. 1990;47: 625-627.
8. O'Keeffe ST, Kazeem H, Philpott RM, Playfer JR, Gosney M, Lye M. **Gait disturbance in Alzheimer's disease: a clinical study.** Age Ageing. 1996;25: 313-316.
9. Roman GC, Tatemichi TK, Erkinjuntti T, et al. **Vascular dementia: diagnostic criteria for research studies.** Report of the NINDS-AIREN International Workshop. Neurology. 1993;43: 250-260.
10. Selkoe DJ. **Aging brain, aging mind.** Sci Am. 1992;267: 134-142.
11. Middelveld-Jacobs I, Van den Boogerd M. **Paratonia, a form of hypertonia in a nursing home population.** Nederlands Tijdschrift voor Fysiotherapie. 1986;96: 85-87.
12. Paulson G, Gottlieb G. **Development reflexes: the reappearance of foetal and neonatal reflexes in aged patients.** Brain. 1968;91: 37-52.
13. Souren LE, Franssen EH, Reisberg B. **Neuromotor changes in Alzheimer's disease: implications for patient care.** J Geriatr Psychiatry Neurol. 1997;10: 93-98.
14. Franssen EH, Kluger A, Torossian CL, Reisberg B. **The neurologic syndrome of severe Alzheimer's disease. Relationship to functional decline.** Arch Neurol. 1993;50: 1029-1039.
15. Hobbelen JS, Koopmans RT, Verhey FR, Van Peppen RP, de Bie RA. **Paratonia: a delphi procedure for consensus definition.** J Geriatr Phys Ther. 2006;29: 50-56.
16. Beversdorf DQ, Heilman KM. **Facilitory paratonia and frontal lobe functioning.** Neurology. 1998;51: 968-971.
17. Benassi G, D'Alessandro R, Gallassi R, Morreale A, Lugaresi E. **Neurological examination in subjects over 65 years: an epidemiological survey.** Neuroepidemiology. 1990;9: 27-38.
18. Gladstone DJ, Black SE. **The Neurological Examination in Aging, Dementia and Cerebrovascular Disease.** part 2: Motor Examination. geriatrics and ageing. 2002;5: 44-49.
19. Koopmans RT, van Hell ME, de Jongh F, Froeling PG, van den Hoogen HJ, van Weel C. **[The course of Alzheimer's disease in a group of nursing home patients: epidemiology, (co)morbidity and mortality].** Ned Tijdschr Geneeskd. 1991;135: 845-850.
20. Tweedy J, Reding M, Garcia C, Schulman P, Deutsch G, Antin S. **Significance of cortical disinhibition signs.** Neurology. 1982;32: 169-173.

21. Risse SC, Lampe TH, Bird TD, et al. **Myoclonus, seizures, and paratonia in Alzheimer disease.** Alzheimer Dis Assoc Disord. 1990;4: 217-225.

22. Arvanitakis Z, Wilson RS, Schneider JA, Bienias JL, Evans DA, Bennett DA. **Diabetes mellitus and progression of rigidity and gait disturbance in older persons.** Neurology. 2004;63: 996-1001.

23. Koopmans RT, Ekkerink JL, Sirre LG, Verkuylen MM, van den Hoogen HJ, van Weel C. **[Multi-infarct dementia in nursing home patients; more comorbidity and shorter life expectancy than in Alzheimer's disease].** Ned Tijdschr Geneeskd. 1992;136: 2223-2227.

24. Bennett HP, Corbett AJ, Gaden S, Grayson DA, Kril JJ, Broe GA. **Subcortical vascular disease and functional decline: a 6-year predictor study.** J Am Geriatr Soc. 2002;50: 1969-1977.

25. Chatterjee A. **Feeling frontal dysfunction: facilitory paratonia and the regulation of motor behavior.** Neurology. 1998;51: 937-939.

26. Tyrrell PJ, Sawle GV, Ibanez V, et al. **Clinical and positron emission tomographic studies in the 'extrapyramidal syndrome' of dementia of the Alzheimer type.** Arch Neurol. 1990;47: 1318-1323.

27. Vahia I, Cohen CI, Prehogan A, Memon Z. **Prevalence and impact of paratonia in Alzheimer disease in a multiracial sample.** Am J Geriatr Psychiatry. 2007;15: 351-353.

28. Tyrrell P, Rossor M. **The association of gegenhalten in the upper limbs with dyspraxia.** J Neurol Neurosurg Psychiatry. 1988;51: 995-997.

29. Hobbelen J, de Bie R, van Rossum E. **Effect of passive movement on severity of paratonia: a partially blinded, randomized clinical trial.** Nederlands Tijdschrift voor Fysiotherapie. 2003;113: 132-137.

30. Dietz V, Sinkjaer T. **Spastic movement disorder: impaired reflex function and altered muscle mechanics.** Lancet Neurol. 2007;6: 725-733.

31. Gajdosik RL. **Passive extensibility of skeletal muscle: review of the literature with clinical implications.** Clin Biomech (Bristol, Avon). 2001;16: 87-101.

32. Gajdosik RL, Vander Linden DW, Williams AK. **Influence of age on length and passive elastic stiffness characteristics of the calf muscle-tendon unit of women.** Phys Ther. 1999;79: 827-838.

33. Mourey F, Manckoundia P, Martin-Arveux I, Tavernier-Vidal B, Pfitzenmeyer P. **Psychomotor disadaptation syndrome. A new clinical entity in geriatric patients.** Geriatrics. 2004;59: 20-24.

34. Pfitzenmeyer P, Mourey F, Tavernier B, Camus A. **Psychomotor desadaptation syndrome.** Arch Gerontol Geriatr. 1999;28: 217-225.

35. Soininen H, Laulumaa V, Helkala EL, Hartikainen P, Riekkinen PJ. **Extrapyramidal signs in Alzheimer's disease: a 3-year follow-up study.** J Neural Transm Park Dis Dement Sect. 1992;4: 107-119.

36. Hobbelen JS, Koopmans RT, Verhey FR, Habraken KM, de Bie RA. **Diagnosing paratonia in the demented elderly: reliability and validity of the Paratonia Assessment Instrument (PAI).** Int Psychogeriatr. 2008;20: 840-852.

37. Diagnostic and statistical manual of mental disorders: DSM-IV. 4th ed. ed. Washington, D.C.: American Psychiatric Association, 1994.

38. Reisberg B, Ferris SH, de Leon MJ, Crook T. **The Global Deterioration Scale for assessment of primary degenerative dementia.** American Journal of psychiatry. 1982;139: 1136-1139.

39. Podsiadlo D, Richardson S. **The timed "Up & Go": a test of basic functional mobility for frail elderly persons.** J Am Geriatr Soc. 1991;39: 142-148.

40. Ettema TP, Droes RM, de Lange J, Mellenbergh GJ, Ribbe MW. **QUALIDEM: development and evaluation of a dementia specific quality of life instrument--validation.** Int J Geriatr Psychiatry. 2007;22: 424-430.

41. Skrbo A, Begovic B, Skrbo S. **[Classification of drugs using the ATC system (Anatomic, Therapeutic, Chemical Classification) and the latest changes].** Med Arh. 2004;58: 138-141.

42. Araki A, Ito H. **Diabetes mellitus and geriatric syndromes.** Geriatr Gerontol Int. 2009;9: 105-114.

43. Sonnen JA, Larson EB, Brickell K, et al. **Different patterns of cerebral injury in dementia with or without diabetes.** Arch Neurol. 2009;66: 315-322.

44. Arvanitakis Z, Wilson RS, Bienias JL, Bennett DA. **Diabetes and parkinsonian signs in older persons.** Alzheimer Dis Assoc Disord. 2007;21: 144-149.

45. Ulrich P, Cerami A. **Protein glycation, diabetes, and aging.** Recent Prog Horm Res. 2001;56: 1-21.

46. Chodzko-Zajko WJ, Proctor DN, Fiatarone Singh MA, et al. **American College of Sports Medicine position stand. Exercise and physical activity for older adults.** Med Sci Sports Exerc. 2009;41: 1510-1530.

47. Sigal RJ, Kenny GP, Wasserman DH, Castaneda-Sceppa C, White RD. **Physical activity/exercise and type 2 diabetes: a consensus statement from the American Diabetes Association.** Diabetes Care. 2006;29: 1433-1438.

6

Passive movement therapy in patients with moderate to severe paratonia; Study protocol of a randomized clinical trial (ISRCTN43069940)

Authors:
Hans Hobbelen
Frans Verhey
Hans Bor
Rob de Bie
Raymond Koopmans

Published in: BMC Geriatrics 2007 Dec.19;7:30.

Abstract

Background:
Paratonia, a form of hypertonia, is associated with loss of mobility and with the development of contractures especially in the late stages of the dementia.
Passive movement therapy (PMT) currently is the main physiotherapeutic intervention. General doubt about the beneficial effects of this widely used therapy necessitates a randomised clinical trial (RCT) to study the efficacy of PMT on the severity of paratonia and on the improvement of daily care.

Methods/Design:
A RCT with a 4-week follow-up period. Patients with dementia (according to the DSM-IV-TR Criteria) and moderate to severe paratonia are included in the study after proxy consent. By means of computerised and concealed block randomisation (block-size of 4) patients are included in one of two groups. The first group receives PMT, the second group receives usual care without PMT. PMT is given according to a protocol by physical therapist three times a week for four weeks in a row. The severity of paratonia (Modified Ashworth scale), the severity of the dementia (Global Deterioration Scale), the clinical improvement (Clinical Global Impressions), the difficulty in daily care (Patient Specific Complaints) and the experienced pain in daily care of the participant (PACSLAC-D) is assessed by assessors blind to treatment allocation at baseline, after 6 and 12 treatments.
Success of the intervention is defined as a significant increase of decline on the modified Ashworth scale. The 'proportion of change' in two and four weeks time on this scale will be analysed. Also a multiple logistic regression analysis using declined/not declined criteria as dependent variable with correction for relevant confounders (e.g. stage of dementia, medication, co-morbidity) will be used.

Discussion:
This study is the first RCT of this size to gain further insight on the effect of passive movement therapy on the severity of paratonia.

Trial registration: Current Controlled Trials ISRCTN43069940

Background

Paratonia is one of the motor problems seen in persons with dementia and was first described by Dupré in 1910 as the inability to relax muscles in combination with a mental disorder [1]. Paratonia is hypothesized to develop centrally but to exert an effect on peripheral biomechanics. Especially in the late stages of dementia it is associated with loss of mobility and with the development of contractures [2-5]. Thus, paratonie has a negative impact on the quality of life and can result in problems with washing and dressing

The prevalence of paratonia ranges from 5% in the early stages of dementia to 100% in the advanced stages [2,5]. We found an estimated prevalence of paratonia of approximately 80% in a group of Dutch nursing home patients with dementia [6]. Passive movement therapy (PMT) is a therapeutic intervention designed to increase the passive extensibility of muscles, ligaments and collagen in order to achieve maximal joint range of motion [7,8]. A recent NIVEL report revealed that PMT is with 28.2% one of the main physiotherapeutic interventions in Dutch nursing homes, with an average duration of 30 minutes per patient per week [9]. This therapy is generally believed to be effective in patients with paratonia [10,11]. Professional workers claim that this therapy, if given shortly before washing and bathing, facilitates the care for the patients, due to improved range of motion of affected limbs. Investigations in other populations, e.g., patients with spasticity and contractures show a temporal effect or a so-called elastic deformation due to the visco-elastic properties in all tissues [7]. However, after 20 to 30 minutes, joint range of motion returns to the starting values. Plastic deformation, or a permanent effect, is only possible if the patient can actively use the gained mobility [7,8]. Furthermore, animal studies indicate that when activated muscles fibres are stretched, which is the case with PMT in paratonia, older tissues are more susceptible to injury on sarcomere level [12]. Given the fact that these frail patients, who often show signs of discomfort during the treatment, are prone to injury and are not able to actively use regained mobility PMT is controversial. Nonetheless, maybe because of a lack of alternatives, or because of pressure of concerned relatives, physicians and physiotherapist start PMT. A pilot study in 15 patients with paratonia confirmed that PMT had positive short term effects, but trend analyses of long term effects showed that after 3 weeks hypertonia increased slightly in 30% in the PMT group in comparison with 10% in the control groups, indicating a possible association with muscle fibre injuries [3]. We feel this is a relevant finding, however, the small sample size of this pilot study, and the lack of a clear operational definition of paratonia did not allow for firm conclusions concerning the efficacy of PMT.

Before designing a new trial with sufficient power we therefore initiated a Delphi procedure with known experts in the field to achieve a new consensus definition of paratonia. After four Delphi-rounds, the experts agreed on 7 criteria for operational defining paratonia (see below) [13]. Consequently these criteria have been assessed on validity and reliability in a 3-phase cross-

sectional study in which this definition was tailored even further and in which we developed an assessment instrument (the Paratonia Assessment Instrument, PAI) for an instant diagnosis of paratonia, thus providing researchers an operational tool for future trials on paratonia [6].

"*Paratonia is a form of hypertonia with an involuntary variable resistance during passive movement. The nature of paratonia may change with progression of the dementing illness (e.g. active assistance (Mitgehen) is more common early in the course of degenerative dementias, whilst active resistance is more common later in the course of the disease). The degree of resistance varies depending on the speed of movement (e.g. a low resistance to slow movement and a high resistance to fast movement). Paratonia increases with progression of dementia. Furthermore, the resistance to passive movement is in any direction and there is no clasp-knife phenomenon." The resistance must be felt in either two directions in one limb or in two different limbs*.

We designed a randomized clinical trial in order to answer three research questions; first, is passive movement therapy an effective intervention on the severity of paratonia in comparison with usual care without passive movement therapy?

Second, is passive movement therapy an effective intervention for improvement of daily care? And finally, does PMT reduce pain during daily care in patients with moderate to severe paratonia.

Methods

To answer these 3 research questions we use a randomised clinical trial with 4 weeks of follow-up.

Patients

The study population consists of patients with dementia (according to the DSM-IV-TR Criteria) and established paratonia according to the Paratonia Assessment Instrument (PAI). The PAI is a construct of five criteria derived from the definition, representing distinct elements of the clinical manifestation of paratonia [6]. The resistance felt during passive movement due to paratonia has to be at least in one of the limbs more marked i.e. a score of 2 or more on the modified Ashworth scale. Possible participants will be identified by trained personnel of participating nursing homes. After identification of participants the researcher checks if the patient is eligible for the study and if so will contact the legal representative(s) of the patient by sending an information leaflet about the study. Patients are only included after proxy consent. Because patients are included after proxy consent we will exclude participants who

indicate during the trial in any way, verbally or nonverbally, not to approve of participation. Patients with an unstable disease, as judged by the nursing home physician, such as progressive malignant cancer or other diseases with an obvious progressive negative effect on the motor function or health status are excluded as well as patients who received passive movement therapy within a period of 4 weeks prior to admission or who receive typical or a-typical antipsychotics.

Interventions

Patients are included in one of two groups after computerised and concealed block randomisation (block size of four). The first group receives usual care with PMT, the second group receives usual care without PMT. Usual care generally consists of grooming and dressing with slow and gentle movements by trained nurses. Some of the participants wear especially designed clothing that enables the nurses to dress patients more easy while the patient is lying in bed or sitting in a wheelchair. Most participants use cushions, mostly manufactured on demand, for a stable position in bed and sit during the day time in comfortable wheelchairs.

PMT is provided in a standardized way. During the first part of passive movement the therapist moves slowly the affected limbs, with the emphasis on lowering the resistance. After this, the therapist tries to reach the end range of motion and possibly stretches the structures very lightly without causing pain. The patients are positioned comfortably supine in bed while the therapist starts PMT with the left arm moving it in flexion and extension (up and down). Subsequently PMT is performed on the right arm, left leg and finally the right leg. The duration of PMT is approximately 20 minutes per patient per session. The treatment group receives PMT, between 8 a.m. and 10 a.m., shortly before being washed and dressed by nursing staff, three times a week for four weeks in a row. In order to safeguard blinding of the assessors for treatment allocation, the control group receives a placebo treatment in the same frequency and in the same time frame. The patients of the control group are positioned comfortably supine in bed after which the therapist stays in the room for approximately 20 minutes. On every treatment day a special signboard on the participant's bedroom door indicates that research is going on advising nursing staff to delay their activities with the participant and not disturb the treatment session.

Outcome measures

The Modified Ashworth scale is the primary outcome measure and tested with an acceptable reliability to assess the severity of paratonia (intrarater reliability; Kendall's Tb 0.62–0.80 and interrater reliability; Kendall's Tb 0.72– 0.77) [14]. It is a 5 point scale ranging from 0 to 4, in which 0 = no resistance to passive movement, 1 = slight resistance during passive movement,

2 = more marked resistance to passive movement, 3 = considerable resistance to passive movement, 4 = severe resistance, passive movement is impossible. Severity of paratonia will be assessed by assessors blinded to treatment allocation at baseline one day prior to treatment start, one day after treatment 6 (after 2 weeks) and one day after treatment 12 (after 4 weeks) between 8 a.m. and 10 a.m. before washing and dressing by nursing staff.

To assess the severity of paratonia all four limbs will be passively moved in flexion and extension with the participant in a comfortable position supine in bed.

As secondary outcome measures we assess The Pain Assessment Checklist for Seniors with Limited Ability to Communicate (PACSLAC-D) [15,16], to assess a decrease of pain as a possible side effect of PMT The PACSLAC-D is an observational assessment instrument that lists 24 items divided in three categories; nonverbal facial signs (10 items), total resistance (6 items) and emotional state (8 items). This version, a reduction of the original 60 item PACSLAC scale had high levels of internal consistency for the complete scale (Cronbach's alpha range 0.82–0.86) and for all subscales (alpha range 0.72–0.82) [17].

An independent observer will assess the PACSLAC-D in both groups by a 5-minute observation of washing and dressing within an hour after the first, sixth and the twelfth treatment session. Another secondary outcome measure is the Clinical Global Impressions scale (CGI) to assess clinical change. With this CGI, especially appointed nurses, who are blinded for treatment allocation, compare the participant with all other patients with paratonia on their ward on a 7 point scale from normal to most severe and rate after 2 and 4 weeks the global improvement also on a 7 point scale from very much improved to very much worse. Finally, the modified "Patient Specific Complaint" (PSC) assessment is used, in which the nurses are asked to address the 3 most difficult items in daily care and rate these items on a visual analogue scale of 100 mm, with at the extreme ends "no trouble at all" and "impossible". The frequencies of all assessments are illustrated in Table 1.

At baseline we will register demographic information and relevant variables such as age, sex, use of medication, type of dementia and severity of the dementia. Severity of dementia is assessed with the Global Deterioration Scale which consists of seven stages of cognitive decline in which stage 1 = no cognitive decline, level 2 = very mild cognitive decline, level 3 = mild cognitive decline, level 4 = moderate cognitive decline, level 5 = moderately severe, level 6 = severe and level 7 = very severe cognitive decline [18]. Psychoactive medications will be classified using the Anatomical Therapeutical Chemical-classification and grouped into antipsychotics, anxiolytics, hypnotics/sedatives, antidepressants, anti-epileptics and miscellaneous (e.g. cholinesterase inhibitors) [19].

Table 1. assessment schedule

Assessment scale *(Assessed by)*	T0	T1	T2
Modified Ashworth ***(Assessor, blind for treatment allocation)***	One day prior to treatment start	One day after treatment 6	One day after treatment 12
PACSLAC ***(independent assessor, blind for treatment allocation)***	on the day of the first treatment	On the day of the sixth treatment	On the day of the twelfth treatment
CGI and PSC ***(Nurse, blind for treatment allocation)***	One day prior to treatment start	One day after treatment 6	One day after treatment 12
GDS ***(Nurse)***	Within a week before trial start		

Sample size

The Modified Ashworth Scale is our primary outcome measure. A trend analysis of the pilot study data showed a worsening of paratonia in 30% of the group with PMT and in 10%, possibly due to natural course, of the group with usual care without PMT [3]. We consider this effect as clinical important. With an alpha of 0.05 and a power of 80% a sample size of 69 patients per group (taking into account a drop-out percentage of 10%) is needed to detect this effect.

Analysis

All data will be analysed with SPSS 15.0. The Modified Ashworth scale, an ordinal 5-point scale, will be measured at 3 times, at baseline (T0) after 2 weeks (T1) and after 4 weeks (T2). Our premise in this study is that PMT causes an accelerated worsening of paratonia over 4 weeks time. Success of the intervention is defined as a significant ($p < 0.05$) difference between the proportion of change on the modified Ashworth scale in the two groups.

To determine any development or change over time of The Modified Ashworth score in the two groups the Stuart-Maxwell statistic will be used.

The difference in proportion of change between the two groups will be calculated and tested for significance [20]. However controlling for relevant confounders e.g. age, sex, severity and type of dementia is not possible with this analysis. Therefore a multiple logistic regression analysis will be performed on the dichotomised outcome measure, "declined" and "stable/ improved", of the difference on T0 and T2 on The Modified Ashworth score.

Missing data will be assumed to be missing at random. The Last Observation Carried Forward method will be used in those cases with no last measurement (T2) yet with valid data from the second assessment (T1). Analyses will be carried out according to the intention to treat principle.

Study timeline

The estimated project time is 18 months. The project will start with an extensive training of relevant staff of all participating nursing homes. The training period will take two months. After this training the inclusion period will start and will run for twelve months. Analysis of data and writing of the report is estimated to take 4 months.

The study has been approved by the local ethical committee CMO nr. 2006/1567, ABR file nr. NL13777.091.06.

The investigator will notify the accredited local ethical committee of the end of the study within a period of 8 weeks. The end of the study is defined as the last patient's last follow-up measurement. Within one year after the end of the study the investigator will submit a final study report with the results, including any publication/ abstracts of the study to the accredited local ethical committee. The investigators are not restricted in any way to publish the results of the study.

Discussion

This study is the first RCT of this size to gain further insight on the effect of passive movement therapy on the severity of paratonia.

Ethical aspects

PMT is a very common physiotherapeutic intervention in patients with moderate to severe paratonia. Although it is controversial and possibly harmful for these frail elderly, in lack of evidence based alternative interventions, most therapists perform PMT. For this reason we designed this RCT in a very pragmatic way, close to daily practice bounded by ethical aspects limiting the time frame of 4 weeks per participant and using assessment tools that are valid and reliable but above all with a minimal burden for the frail participants. Although we realise that further assessments after the end of the treatment period could have given more insight in the duration of the effect of PMT, the frailty of the participants prevails over the aims of research. For the same reason we decided to use no invasive methods, such as muscle biopsy to assess possible tissue damage.

Bias

With the use of the consensus definition a homogeneous population should be guaranteed although research in the more severe cases of paratonia indicates that if the resistance in affected limbs is very high the assessor is not able to accelerate the movement and adequate differentiation with Parkinsonian (lead pipe) rigidity becomes impossible [6]. Furthermore, we

did not specify the type of dementia in the inclusion criteria. At this moment we know that in the advanced stages of the disease all patients have paratonia. However, it is unclear if there are any dissimilarities in the development and severity of paratonia in different types of dementia. Therefore paratonia, diagnosed in different dementias, could react inconsistently to PMT and although we take this into account in our analysis this uncertainty could be a potential source of bias.

With this study, we hope to clarify the effect of passive movement therapy on moderate to severe paratonia and hopefully gain some scientific basis for the use of this treatment or to abandon PMT in this population. The controversy between the hypothesis of the research team that PMT is possibly harmful and the assumption of nurses and relatives that it is beneficial, necessitates a thorough organisation for keeping all assessors blind for treatment allocation. Therefore randomisation is done in a block size randomisation system with block size of four. For each participating nursing home a new sequence is calculated at the faculty of Epidemiology of the Maastricht University. The blinding of the assessors can be compromised by an incidental verbal hint of one of the participants although most of the participants are in the advanced stage of dementia and lost there capacity of speech.

validity

The research will be conducted in four different nursing homes, that will enhance extrapolation of study findings. However, due to the fact that at least 4 different geriatric physical therapists will perform PMT and at least two different assessors of the severity of paratonia will participate, the internal validity may become compromised. A protocollized way of performing PMT and an extensive training of all therapists and assessors involved should ensure internal validity of this study and reliability of assessed outcomes.

The results of this randomised controlled trial will be published in a scientific journal and will be used for recommendations in the guideline of geriatric physical therapy and implemented in current physical therapy practice. This guideline will be developed according to method of clinical practice guideline development of the Royal Dutch Physiotherapy Association (KNGF) [21].

Competing interests

The authors declare that they have no competing interests. The investigators are not restricted in any way to publish the results of the study

Authors' contributions

JH designed the study and drafted the manuscript, FV participated in the design of the study and helped to draft the manuscript, JB helped writing the statistical paragraph of the protocol, RB participated in the design of the study and helped to draft the manuscript, RK participated in the design of the study and to draft the manuscript. All authors have given final approval of the version to be published.

Acknowledgements

This study is supported by a grant of the Vitalis WoonZorg Groep Eindhoven, the Netherlands.

References

1. Dupré E: **Débilité mentale et débilité motrice associées.** Rev Neurol 1910, 20(semestre 2):54-56.
2. Franssen EH, Kluger A, Torossian CL, Reisberg B: **The neurologic syndrome of severe Alzheimer's disease. Relationship to functional decline.** Arch Neurol 1993, 50(10):1029-1039.
3. Hobbelen J, de Bie R, van Rossum E: **Effect of passive movement on severity of paratonia:a partially blinded, randomized clinical trial.** Nederlands Tijdschrift voor Fysiotherapie 2003, 113(6):132-137.
4. Paulson G, Gottlieb G: **Development reflexes: the reappearance of foetal and neonatal reflexes in aged patients.** Brain 1968, 91:37-52.
5. Souren LE, Franssen EH, Reisberg B: **Neuromotor changes in Alzheimer's disease: implications for patient care.** J Geriatr Psychiatry Neurol 1997, 10(3):93-98.
6. Hobbelen JSM, Koopmans RTCM, Verhey FRJ, Habraken KM, de Bie RA: **Diagnosing paratonia in the demented elderly; reliability and validity of the paratonia assessment instrument (PAI).** International Psychogeriatrics 2007 in press.
7. Gajdosik RL: **Passive extensibility of skeletal muscle: review of the literature with clinical implications.** Clin Biomech (Bristol, Avon) 2001, 16(2):87-101.
8. Van Wingerden BAM: **Mobilization.** Connective tissue in rehabilitation 1997:197-241.
9. Leemrijse C, de Boer M, Ribbe M: **Paramedic care in Dutch nursing homes; explaining the differences?** Utrecht: NIVEL 2005.
10. Arnts W, Van Oostwaard P, Rooyakkers A: **Physiotherapy treatment for paratonia.** Nederlands Tijdschrift voor Fysiotherapie 1989, 99:216-220.
11. Pomeroy V: **Immobility and severe dementia: when is phyiotherapy treatment appropriate.** Clinical Rehabilitation 1994, 8:226-232.
12. Brooks SV, Faulkner JA: **The magnitude of the initial injury induced by stretches of maximally activated muscle fibres of mice and rats increases in old age.** J Physiol 1996, 497(Pt 2):573-580.
13. Hobbelen JS, Koopmans RT, Verhey FR, Van Peppen RP, de Bie RA: **Paratonia: a delphi procedure for consensus definition.** J Geriatr Phys Ther 2006, 29(2):50-56.
14. Waardenburg H, Elvers W, Van Vechgel F, Oostendorp R: **Can paratonia be measured reliably? Evaluation of the reliability of a visual analogue scale and the modified tonus scale of Ashworth for measuring paratonia.** Nederlands Tijdschrift voor Fysiotherapie 1999, 102(2):30-35.
15. Fuchs-Lacelle S, Hadjistavropoulos T: **Development and preliminary validation of the pain assessment checklist for seniors with limited ability to communicate (PACSLAC).** Pain Manag Nurs 2004, 5(1):37-49.
16. Zwakhalen SM, Hamers JP, Abu-Saad HH, Berger MP: **Pain in elderly people with severe dementia: a systematic review of behavioural pain assessment tools.** BMC Geriatr 2006, 6:3.
17. Zwakhalen SM, Hamers JP, Berger MP: **Improving the clinical usefulness of a behavioural pain scale for older people with dementia.** J Adv Nurs 2007, 58(5):493-502.
18. Reisberg B, Ferris SH, de Leon MJ, Crook T: **The Global Deterioration Scale for assessment of primary degenerative dementia.** American Journal of psychiatry 1982, 139:1136-1139.
19. Medicines NCO: Guidelines for ATC Classification. Oslo: WHO Collaborating Center for Drugs Statistics Methodology 1990.

20. Twisk JWR: **Applied longitudinal data analysis for epidemiology: a practical guide.** Cambridge: Cambridge University Press; 2003.

21. Hendriks HJM, Bekkering GE, van Ettekoven H, Brandsma JW, van der Wees PJ, de Bie RA: **Development and implementation of national practice guidelines: a prospect for continuous quality improvement in physiotherapy.** Physiotherapy 2000, 86(10):535-547.

Pre-publication history

The pre-publication history for this paper can be accessed here:

http://www.biomedcentral.com/1471-2318/7/30/prepub

7

Passive movement therapy in severe paratonia;

A multi-centre randomized clinical trial

Authors:
Hans Hobbelen
Frans Tan
Frans Verhey
Raymond Koopmans
Rob de Bie

Submitted

Abstract

Background

Paratonia, a distinctive form of hypertonia in dementia, causes severe movement dysfunction in late stage dementia. Passive Movement Therapy (PMT) is often used to decrease the high muscle tone, but its efficacy has never been shown.

Objectives

Investigate the effect of PMT on the muscle tone after two and four weeks of treatment.

Methods

A multi-centre single-blinded RCT. Nursing home residents with dementia (according to the DSM-IV-TR Criteria) and moderate to severe paratonia were randomly assigned to either a PMT or control group. The PMT group received PMT 3 times a week during 4 weeks. The control group received no PMT. The primary outcome variable was severity of paratonia as assessed at baseline, after 2 and 4 weeks of PMT, measured by the modified Ashworth scale (MAS). Secondary outcomes were clinical change (Clinical Global Impression, CGI), the carer's burden (modified patient specific complaints, PSC) and level of pain during morning care (Pain Assessment Checklist for Elderly with Limited Ability to Communicate, Dutch version, PACSLAC-D). The MAS, PACSLAC-D and PSC were investigated using multi-level mixed linear analysis, the CGI with cross-tabulation chi-square analysis.

Results

Hundred and ten participants from 12 Dutch nursing homes were enrolled, of whom 101 patients participated in the study; data from 47 patients in the PMT group and 54 controls were analysed. Patients receiving PMT had no better outcome on paratonia measures, or on CGI, PSC and PACSLAC-D.

Limitation

The validity of the PCS has not been established yet.

Conclusion

PMT has no beneficial effects and should therefore not be recommended as intervention in severe paratonia.

Trial registration: Current Controlled Trials ISRCTN43069940

Keywords; Paratonia, Dementia, Passive Movement Therapy, Movement Disorders

Introduction

Dementia is frequently accompanied by motor dysfunctions, especially in the advanced stages.[1-5] Paratonia, a form of hypertonia different from Parkinson's rigidity and spastic hemiparesis, is a motor dysfunction that is notably present in 90-100% of people in the advanced stages of dementia.[6] It results in a characteristic bed posture of flexed arms and legs and an uplifted head floating above the pillow, is accompanied with pain, and affects mobility and quality of life.[6, 7]

Consequently, caregiver burden increases exponentially with increasing muscle tone and decreasing abilities of the patient.[6] Passive movement therapy (PMT) aims to decrease high muscle tone and to sustain range of motion of the affected joints, and is the main therapy applied by physiotherapists in nursing homes.[8-10] While some claim that it reduces the problems of cargivers and nurses in daily care, others are more sceptic about the beneficial effects. There is some supporting evidence for a positive effect of PMT shortly after the treatment.[11-14] However, the most common frequency of PMT is 2 to 3 times a week implying a more extended effect of treatment.[8, 9] A pilot study (n=15) with PMT at a frequency of 3 times a week with a follow-up of 3 weeks showed an unexpected trend in which muscle tone increased in the PMT group, as compared to controls [13] Although the participants of this pilot were probably not a homogeneous study sample, the results emphasise the need to study the effects of PMT in this frail population.

The recent international consensus definition of paratonia and the development of the Paratonia Assessment Instrument (PAI) as a valid and reliable assessment instrument to diagnose paratonia enables further research in a more homogeneous population.[15, 16] To investigate the effect of PMT after two and four weeks of treatment in severe paratonia, a multi-centre randomised clinical trial has been carried out. Furthermore, we studied the effect of PMT on the caregiver's burden after two and four weeks and the short-term effect of PMT on the experienced pain of patients during morning-care.

Methods

The study is a single-blinded multi-centre randomized clinical trial with a four-week follow-up period.[17] The local ethical committee CMO Arnhem-Nijmegen, the Netherlands, approved the study and filed it under nr. 2006/1567, ABR file nr. NL13777.091.06. The trial is registered at Current Controlled Trials ISRCTN43069940

Participants

For this study 19 physical therapy departments of nursing homes in the Netherlands were approached. Only after consent for participation by the board of directors from each institution, did recruitment of eligible patients start. Recruitment took place in the participating nursing homes by physical therapists trained to diagnose paratonia with the PAI and to assess the severity of paratonia with the Modified Ashworth Scale (MAS; see below for further explanation).[18]

Nursing home residents were included when 1) they met the DSM-IV-TR Criteria for dementia and 2) had moderate to severe paratonia defined as a score on the MAS of at least 2 (= more marked resistance to passive movement) in at least one limb. Patients were excluded when: 1) they were prescribed antipsychotic medication; 2) they received PMT less than four weeks prior to trial start; 3) had an unstable health problem or disease prior to admission or during the trial and 4) showed signs of challenging behaviour towards the therapist and/or the intervention.

Participants were only included after written proxy consent.

Randomisation

After computerised and concealed block randomisation (block-size of 4) patients were assigned to one of two groups. For every participating institution a new randomisation list was made at the department of epidemiology at Maastricht University. At every institution patients were numbered in order of receiving proxy consent and this order was permanent. The randomisation code (per patient) was only available to the assigned therapists and was kept secret from all other personnel involved, including the primary investigator.

Intervention

Patients were assigned either to the group that received PMT or the control group that received no PMT. PMT was provided in a standardised way by trained local physical therapists. During the first part of passive movement the therapist moves the affected limbs slowly, with emphasis on lowering muscle resistance. After this, the therapist tries to reach the end range of motion and possibly stretches the structures very lightly without causing pain. The patients are positioned comfortably supine in bed while the therapist starts PMT with the left arm; moving it in flexion and extension (up and down). Subsequently, PMT is performed on the right arm, left leg and finally the right leg. The duration of PMT is approximately 20 minutes per patient per session. [17] The treatment group and the placebo group were visited by the therapists, between 8 a.m. and 10 a.m., before washing and dressing by nursing staff, three times a week for four weeks. The intervention was spread out over the 5 working days of the week (Monday – Friday) allowing for two consecutive treatment days as a maximum. Nursing staff and all assessors were blinded for treatment allocation.

To guarantee blinding of nursing staff, the therapists were instructed to lock the door and put a 'do not disturb' sign on the door along with a note of their presence. The placebo treatment consisted of positioning the participant comfortably supine in bed and sitting alongside the bed for an equal duration of a PMT treatment.
Although it was impossible to blind the participants, all participants were in the advanced stages of dementia with limited ability to communicate, therefore minimising the chances for revealing towards nursing staff and assessors the treatment assignment.

Assessments
The Modified Ashworth Scale (MAS) was the primary outcome measure to assess the severity of paratonia.(18) It is a 5-point ordinal scale ranging from 0 to 4, in which 0 = no resistance to passive movement, 1= slight resistance during passive movement, 2= more marked resistance to passive movement, 3 = considerable resistance to passive movement, 4= severe resistance, passive movement is impossible.
The assessors, local physical therapists trained on the job, were instructed to assess the MAS between 8 a.m. and 10 a.m. before washing and dressing by nursing staff at baseline (T0) one day prior to treatment start; after 2 weeks (T1) one day after treatment 6; and after 4 weeks (T2) one day after treatment 12. The assessments, with the participants comfortably supine in bed, started with moving the left arm in flexion/extension and abduction/adduction of the shoulder and next flexion/extension of the elbow. Subsequently, the same movements were assessed in the right arm. After this, flexion/extension and abduction/adduction of the left leg and the right leg were tested.

Pain during morning care was a secondary outcome measure and assessed with the Pain Assessment Checklist for Seniors with Limited Ability to Communicate (PACSLAC-D). The PACSLAC-D is an observational assessment instrument that lists 24 items clustered into three categories: non-verbal facial signs (10 items), total resistance (6 items) and emotional state (8 items).[19, 20, 21] Within an hour after the first, sixth and the twelfth treatment, an observer assessed the PACSLAC-D during the first 10 minutes of morning-care of all participants. A cut-off score of 4 or higher is judged as an indication of pain.[21]

Clinical changes were assessed one day prior to the start of the treatments and one day after treatments 6 and 12 by nursing-staff using the Clinical Global Impressions scale (CGI).[22] The CGI compares the participant with all other patients with paratonia on the ward on a 7-point scale from normal to most severe. The same question was asked after 2 and 4 weeks with an additional question to rate the global improvement also on a 7-point scale from very much improved to very much worse.

Finally, the nurses were asked to address the 3 most difficult items in daily care and rate these items on a visual analogue scale of 100mm, ranging from "no trouble at all" and "impossible". This modification of the Dutch PSC list (Patient Specific Complaint list) was completed and rated one day prior to the start of the treatment, and with their original score visible the same 3 items were rated again a day after treatment 6 and 12.[23]

At baseline age, sex, use of medication, type of dementia and severity of the dementia were registered. Severity of dementia was assessed with the Global Deterioration Scale which consists of seven stages of cognitive decline ranging from stage 1= no cognitive decline, level 2= very mild cognitive decline, level 3 = mild cognitive decline, level 4= moderate cognitive decline, level 5=moderately severe, level 6=severe to stage 7= very severe cognitive decline.[24]

Analysis

All data was analysed with SPSS 16.0 for Macintosh. For the analysis we summed the Ashworth score of all movement directions of both arms, with a maximum score of 48 points, and subsequently of both legs, with a maximum score of 32 points and considered this as continuous data. The Ashworth score was analysed with mixed effects linear models on three levels, time level nested within patient level nested within institution.[25]

This procedure was also used in the analysis of the PACSLAC-D and the PSC. To account for the dependency of the three subsequent questions about the carer's strain of the PSC these data have been fully cross-classified with time at first level.

In all analyses we accounted for the differences of the different types and stages of dementia, the baseline assessments and a natural time effect. In order to test if PMT has a different effect in the different nursing homes, the different types of dementia or stages of the disease, we entered these factors as interaction terms in the models.

Missing data was treated as missing at random.

Finally the CGI has been analysed with cross-tabulation chi-square.

For all analyses we considered p-values < 0.05 statistically significant.

The analysis was carried out according to the intention-to-treat principle.

Power analysis has been carried out and resulted, with an alpha of 0.05 and a power of 80%, in a sample size of 69 patients per group (taking into account a drop out percentage of 10%).[17]

Results

Twelve nursing homes, in both rural and urban regions of the Netherlands, participated in the trial. A total of 130 patients were considered eligible, of whom 110 (85%) agreed by proxy consent to participate. Ultimately, 102 of them participated and data of 101 participants were analysed. Data collection took place between April 2007 and April 2009.

The number of participants varied between the nursing homes. In one institution 26 and in another 20 participants were randomised; in the remaining ten institutions this varied from 10 to 1.

Figure 1 shows the study flow chart according to the CONSORT statement.[26]

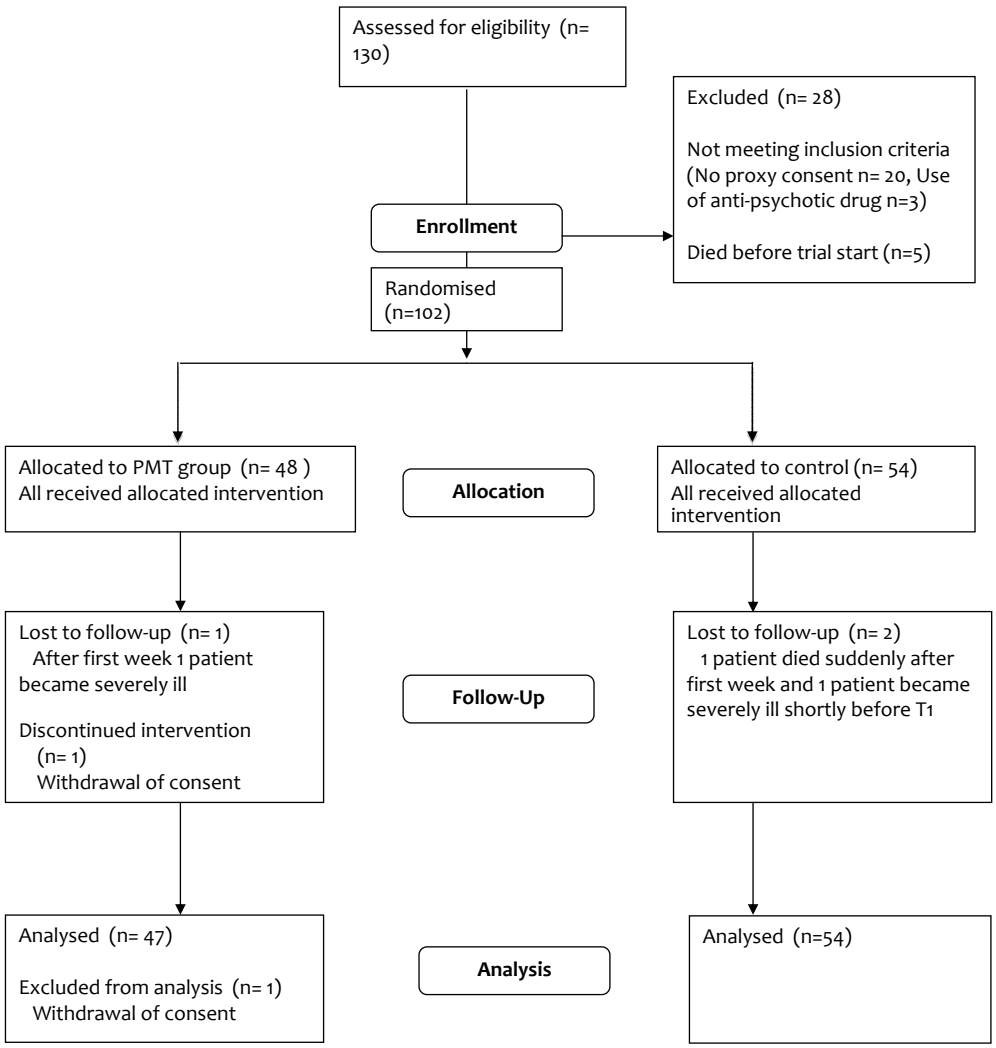

Figure 1. Study flow chart

Of the participants 82.2% (n=83) were female. The mean age was 84 years (range 67-98 years) and most of the participants (65.3%, n=66) were in the most severe stage of dementia GDS 7 and 34.7% (n=35) in GDS 6 stage. Sixty-three percent (n=64) had Alzheimer dementia (AD), 18% (n=18) had vascular dementia (VaD), 11% (n=11) a combination of AD and VaD, 4% (n=4) had a diagnosis of Lewy Body dementia and in 4% (n=4) of patients dementia was not otherwise specified.

See table 1 for patient characteristics and distribution for the control and PMT group, respectively.

Table 1. Baseline patient characteristics

	PMT group (n=47)	Controls (n=54)	P-value T-test
sex			
Women, n (%)	38 (80.9%)	45 (83.3%)	.75
Men, n (%)	9 (19.1%)	9 (16.7%)	
Age, median (range)	84 (74-98)	83 (67-97)	.44
Type of dementia;			
Alzheimer	26 (55.3%)	38 (70.4%)	.15
Vascular	10 (21.3%)	8 (14.8%)	
Mix Alz.-vasc	7 (14.9%)	4 (7.4%)	
Lewy Body	1 (2.1%)	3 (5.6%)	
Not otherwise specified	3 (6.4%)	1 (1.9%)	
Severity of dementia;			
GDS 6, n (%)	15 (31.9%)	20 (37%)	.80
GDS 7, n (%)	32 (68.1%)	34 (63%)	
Medication;			
Use of analgesics, n (%)	11 (23.4%)	9 (16.7%)	.40
median use of medicines, n (range)	4 (0-12)	3 (0-9)	.57
Co-morbidities;			
Co-morbidity, Median (range)	3 (0-8)	2 (0-10)	.34
DM II, n (%)	4 (10.5%)	12 (26.1%)	.07
Stroke/TIA, n (%)	10 (21.1%)	11 (19.6%)	.79
Musculo-skeletal, n (%)	17 (44.7%)	17 (37%)	.32

At first glance the results show an increase of muscle tone in the PMT group. The carer's strain and the observed pain of the participants during morning care decreased in both groups. The median score of the CGI remained unchanged in both groups. See table 2.

Table 2. Baseline and changes in clinical outcome

	Baseline				***T1 (2 weeks, 6 treatments)***		***T2 (4 weeks, 12 treatments)***		***Mean change (T2-T0)***			
	PMT	Control	*Difference*	*P-value*	PMT	Control	PMT	Control	PMT	Control	Mean difference	P-value T-test
MAS Arms	23.1 (12)	17.5 (10.3)	*5.6 (2.2)*	*.01*	24 (12.1)	19.1 (11.8)	24.8 (10.9)	19 (10.9)	***+2.3 (7.9)***	***+1.2 (6.9)***	***1.2 (1.5)***	***.45***
MAS legs	16.4 (8.2)	17.3 (8)	*-0.9 (1.6)*	*.45*	17 (8.1)	17.3 (8.1)	18.5 (7.2)	17.3 (8.5)	***+2.2 (4.9)***	***+0.1 (4.9)***	***2.1 (1)***	***.04***
PSC problem 1	71.3 (14.9)	65.5 (15.3)	*5.8 (3)*	*.056*	65.7 (19)	59.3 (19.8)	65 (20.4)	57.5 (20.9)	***-7.6 (14.3)***	***-7.6 (20.5)***	***0 (3.6)***	***1***
PSC problem 2	68.5 (18)	65.7 (14.6)	*2.9 (3.3)*	*.39*	64.6 (23.2)	61.9 (19.5)	64.6 (21)	61.5 (20.7)	***-4.9 (14.5)***	***-3.9 (18.2)***	***1 (3.4)***	***.76***
PSC problem 3	65 (18.2)	60.6 (18.1)	*4.4 (3.7)*	*.24*	62 (21.1)	58.6 (21.5)	62.8 (20.8)	56.7 (22.9)	***-3.2 (17.2)***	***-3.4 (15.9)***	***0.23 (3.5)***	***.95***
PACSLAC-D	4 (3.5)	4.7 (4.1)	*0.7 (0.8)*	*.37*	3.9 (4)	4.6 (3.8)	3.7 (2.9)	3.8 (3.3)	***-0.4 (2.4)***	***-0.8 (2.5)***	***0.4 (0.5)***	***.42***
CGI	5 (3-7)	5 (2-7)	*0.3 (0.3)*	*.19*	5 (1-7)	5 (2-7)	5 (1-7)	5 (3-7)	***-0.3 (1.3)***	***+0.2 (1.2)***	***0.5 (0.3)***	***.08***

Data are mean (SD) or difference (SD) or median (range). MAS= Modified Ashworth Scale. PSC= modified Patient specific complaints. PACSLAC-D= Pain assessment checklist for seniors with limited ability to communicate-Dutch version.
MAS arms max. score 48; positive value indicate increase of paratonia MAS legs max. score 32; positive value indicate increase of paratonia PSK max. score 100; negative value indicate decrease of carer's burden PACSLAC-D max. score 24; negative value indicate decrease of pain CGI 7-point ordinal scale; positive value indicate worsening of paratonia

The effect of PMT on muscle tone

The mixed model showed that PMT had no statistically significant effects either on the muscle tone of both arms (ß=2.01, sd=1.17, p=.09) nor on tone in both legs (ß=1.37, sd= 0.76, p=.08) after two and four weeks. See Table 3 and Figure 2.

Table 3. Mixed model estimates Ashworth score of arms and legs respectively

Mixed model Ashworth score of both arms				
Parameter	Estimate (ß)	Standard error	Degrees of freedom	p-value
Intercept	9.48	3.36	103.92	0.01
Intervention	2.01	1.17	75.48	0.09
GDS	4.44	1.46	81.21	0.003
Baseline	0.72	0.06	78.5	<0.001
Type of dementia	.	.	77.2	<0.001
Alzheimer	-6.31	2.87	75.2	0.03
Vascular dem.	-11.44	3.02	77.3	<0.001
Lewy Body	-2.69	3.84	75.1	0.49
Alz.+vasc	-9.04	3.27	77.01	0.01
Not otherwise specified	0	0	.	.
Time	0.27	0.73	92.59	0.72
Mixed model Ashworth score of both legs				
Intercept	3.43	2.29	107.8	0.14
Intervention	1.38	0.76	80.5	0.08
GDS	1.15	0.95	86.5	0.23
Baseline	0.76	0.05	85.2	<0.001
Type of dementia	.	.	81	.036
Alzheimer	-1.7	1.9	78.7	0.37
Vascular dem.	-4.06	1.99	80	0.04
Lewy Body	1.33	2.55	78.2	0.6
Alz.+vasc.	-1.74	2.16	80.5	0.42
Not otherwise specified	0	0	.	.
Time	1.07	0.53	91.95	0.049

3-level mixed-effects linear regression model with a random intercept at both institution- and patient level.

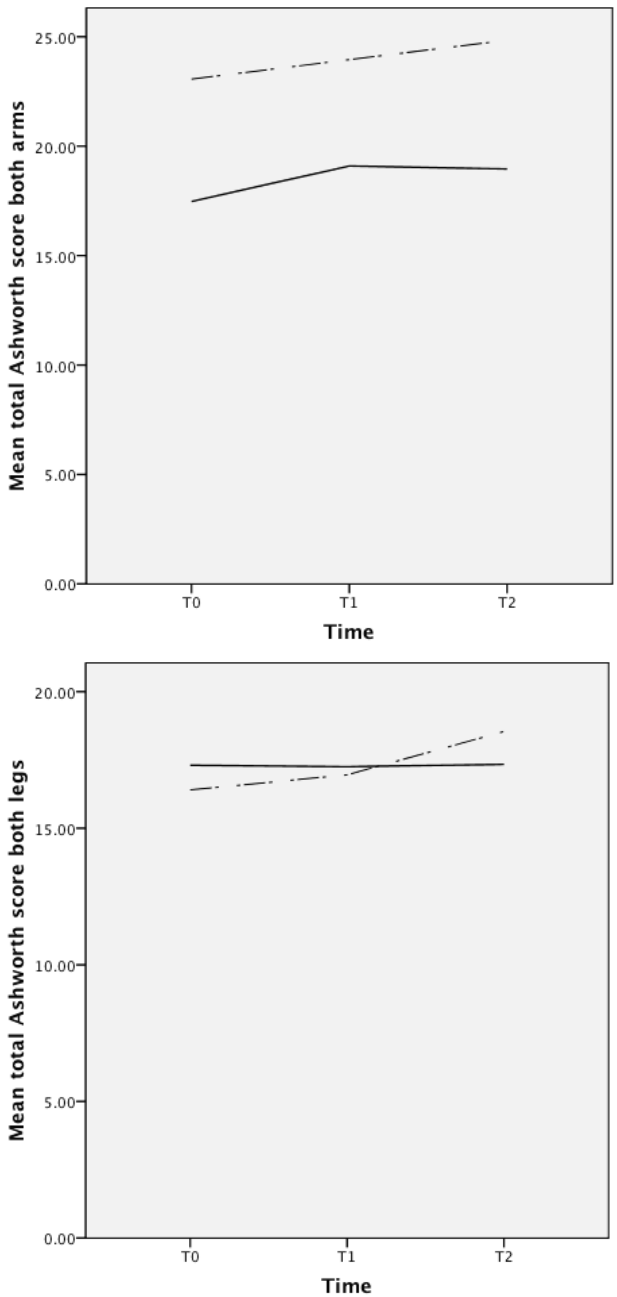

Figure 2. plots of the mean total observed Ashworth score on Baseline, T1 and T2 for both arms and both legs respectively. Legend: PMT Control

Independent of the intervention, we found differences in the development of paratonia between the different types of dementia (p=.036 legs, p=.001 arms) indicating that patients with VaD improved slightly during the trial period, while in all patients with other types of dementia the muscle tone increased. This increase was in general a slight gradual increase, except in the LBD group in which a specific pattern was found with a steep increase of the muscle tone between T0 and T1 and a decline between T1 and T2.
The follow-up measurements in arms and legs were highly dependent on the baseline measurement (p<.001).

The effect of PMT on the caregiver's strain

Clinical Global Impression

The median score of both groups was 5 (marked paratonia) at baseline and remained stable during the trial period. After two weeks, the change scores on the CGI were similar for both groups; respectively in the PMT group and control group 2 patients were classified as 'much improved', 9 and 10 as 'minimally improved', 30 and 32 showed 'no change', 2 and 5 'minimally worse' and none and 2 'much worse'. After four weeks the PMT group changed more. However, the direction varied, either improving and worsening; respectively in the PMT group and control group 4 and 6 patients were classified as 'much improved', 13 and 8 'minimally improved', 22 and 35 'no change', 4 and 2 'minimally worse' and 2 and none 'much worse'. Pearson chi-square analysis showed no statistically significant differences between the PMT and control group (p=.60 after two weeks and p=.14 after four weeks).

Patient Specific Complaint

Specifically focusing on the caregiver's strain at the individual level of the participant, in a 3-level mixed-effects linear regression model with a random intercept and random slope (with respect to treatment) at institutional level and an unstructured variance-covariance structure at 'time x problem' level, a significant interaction was found between PMT and GDS (ß = -12.8, Standard error 5.49, p<.02). GDS 7 patients remained stable whereas GDS 6 patients appeared to improve during the 4 weeks. This improvement was significantly less in the PMT group. This model showed also a significant interaction term of PMT and LBD patients with the AD-VaD. participants as contrast (p<.002).
In other words the caregiver's strain did not change significantly in any type of dementia except in LBD patients, whose PSC scores improved substantially as indicated by their carers.

The effect of PMT on experienced pain during care moments

At baseline 49.5% (n=49) had a PACSLAC-D score greater or equal to 4, indicating possible pain during the observation. The mean pain score was 7.10 (SD 3.7; ranges 4-18). The participants with pain were equally distributed over both groups (PMT group: 47%, n=21; control group:

53%, n=28). The experienced pain during care moments within the hour after the intervention decreased in the PMT group, but even more in the control group. The mixed model analyses showed that only the first measurement was significantly related with the differences in pain score during the trial (ß= 0.67, Standard error = 0.05, p<.001).

Discussion

PMT has no beneficial effects for patients with moderate and severe paratonia.
This study confirms that PMT does not decrease muscle tone but shows a trend towards worsening of joint and limb stiffness compared with controls. Although not statistically significant, we found it clinically very relevant because this therapy is meant to reduce the muscle tone. The higher Ashworth score in the PMT group could be caused by so-far undetected micro-traumata while stretching the tissues of the frail elderly. This hypothesis is supported by animal studies indicating that older muscle tissue, if stretched in an activated condition, is very susceptible to injury on sarcomere level.[27]
The observation of differences in the severity of paratonia in the different types of dementia is new indicating possible distinct features. On the other hand it can also be a reflection of differences in paratonia in dementias with a different pathogenesis, not yet filtered out by the PAI. In vascular dementia, it is known that movement disorders are already present very early in the disease, probably influencing the stiffness of tissues differently than when the movement disorders develop gradually during progress of the dementia. [28] In LBD fluctuation of movement disorders are known, which is probably the cause of the fluctuating results at T1 and T2 in the Ashworth score. [29] The improvement indicated by the nurses in the LBD participants with PMT is noteworthy. These results indicate that PMT may have different effects in larger samples of vascular dementia and LBD patients. This should be examined in further studies.

This is the first multi-centre randomised controlled trial investigating a physiotherapeutic intervention in dementia patients with paratonia. The training with the treatment protocol and the good organisation to ensure blinding gives strength to the results obtained.
The mixed linear effects analysis used is generally seen as best practice for longitudinal data and accounts for the correlated structure of the data.[25]
Furthermore, by treating the different nursing homes as a level in these analyses accounts for possible different interpretations of the ordinal levels of the MAS, our primary outcome.

Limitations
In order to reach sufficient participants we were forced to include more institutions than we originally planned.[17] The fact that more physiotherapists were involved in giving PMT and in

the assessments lowers the reliability of this study, but expands the generalisability of our findings.

The separate randomisation lists per institution caused a small deviation in the sample size of the two groups, which was slightly aggravated by the exclusion of the unwilling PMT participant. We believe, however, that this had no negative effects on the outcome of this trial.

To obtain insight in the effect of PMT on the carer's burden we incorporated the CGI and PSC to be filled in by nursing staff. The CGI was used to get a global picture of the effect of PMT on the carer's burden translating their qualification of 'decreased/stable/improved' in 'easier/same/heavier' in care. The questions of the PSC were directly focused on the strain of daily care to get a better picture of the effect of PMT. However the results of the PSC for assessing the carer's burden remain unexplained. In retrospect we doubt the validity of this instrument in this setting, for we transferred the original PSC into a proxy assessment scale. Therefore, we think that results might be biased, and in future studies proper validation of this instrument is called for.

Conclusion

PMT has no beneficial effects on the muscle tone in two or four weeks or on the experienced pain during care moments shortly after the treatment. There is no indication that the carer's strain decreases as a consequence of PMT. PMT is therefore not recommended as an intervention in severe paratonia.

Acknowledgement

We thank all participants and their relatives for their cooperation in this trial. We thank all participating elderly health care institutions; ' de Zorgboog' Helmond, 'AxionContinu' Utrecht, 'Zorgroep Elde' Boxtel, 'Stichting Nieuwebrug' Ammerzoden,'stichting Zorgcirkel' Purmerend,'stichting Quarijn' Doorn,'stichting zorggroep Noord West Veluwe' Harderwijk, ' stichting Meavita' Den Haag, 'Het Parkhuis' Dordrecht,'Rivas Zorggroep' Leerdam, 'stichting Circonflex' Zevenbergen and 'Vitalis WoonZorg Groep' Eindhoven. Furthermore, we thank all physiotherapists and other personnel who actively contributed to this trial. We thank José van Lier for her enthusiastic contribution to this trial by adopting a part of this trial for her own academic education, and finally Bob Wilkinson from the Maastricht University Translation and Editing Department.

References

1. Allan LM, Ballard CG, Burn DJ, Kenny RA. **Prevalence and severity of gait disorders in Alzheimer's and non-Alzheimer's dementias.** J Am Geriatr Soc 2005;53(10):1681-1687.
2. Camicioli R, Howieson D, Oken B, Sexton G, Kaye J. **Motor slowing precedes cognitive impairment in the oldest old.** Neurology 1998;50(5):1496-1498.
3. Kurlan R, Richard IH, Papka M, Marshall F. **Movement disorders in Alzheimer's disease: more rigidity of definitions is needed.** Mov Disord 2000;15(1):24-29.
4. Prehogan A, Cohen CI. **Motor dysfunction in dementias.** Geriatrics 2004;59(11):53-54, 56, 59-60.
5. Scherder E, Eggermont L, Swaab D, et al. **Gait in ageing and associated dementias; its relationship with cognition.** Neurosci Biobehav Rev 2007;31(4):485-497.
6. Souren LE, Franssen EH, Reisberg B. **Neuromotor changes in Alzheimer's disease: implications for patient care.** J Geriatr Psychiatry Neurol 1997;10(3):93-98.
7. Middelveld-Jacobs I, Van den Boogerd M. **Paratonia, a form of hypertonia in a nursing home population.** Nederlands Tijdschrift voor Fysiotherapie 1986;96:85-87.
8. Leemrijse C, de Boer M, Ribbe M. **Paramedic care in Dutch nursing homes; explaining the differences?** Utrecht: NIVEL; 2005.
9. Luijckx-Comeau V, Brooijmans-Reuser M. **Passive mobilisation: evidence versus daily practice.** Fysiotherapie en ouderenzorg 2008;22(1):30-36.
10. Pomeroy V. **Immobility and severe dementia: when is phyiotherapy treatment appropriate.** Clinical Rehabilitation 1994;8:226-232.
11. Gajdosik RL. **Passive extensibility of skeletal muscle: review of the literature with clinical implications.** Clin Biomech (Bristol, Avon) 2001;16(2):87-101.
12. Van Wingerden BAM. **mobilization.** In: Connective tissue in rehabilitation: Scripro Verlag Schaan Liechtenstein, 1997:197-241.
13. Hobbelen J, de Bie R, van Rossum E. **Effect of passive movement on severity of paratonia:a partially blinded, randomized clinical trial.** Nederlands Tijdschrift voor Fysiotherapie 2003;113(6):132-137.
14. Bautmans I, Demarteau J, Cruts B, Lemper JC, Mets T. **Dysphagia in elderly nursing home residents with severe cognitive impairment can be attenuated by cervical spine mobilization.** J Rehabil Med 2008;40(9):755-760.
15. Hobbelen JS, Koopmans RT, Verhey FR, Habraken KM, de Bie RA. **Diagnosing paratonia in the demented elderly: reliability and validity of the Paratonia Assessment Instrument (PAI).** Int Psychogeriatr 2008;20(4):840-852.
16. Hobbelen JS, Koopmans RT, Verhey FR, Van Peppen RP, de Bie RA. **Paratonia: a delphi procedure for consensus definition.** J Geriatr Phys Ther 2006;29(2):50-56.
17. Hobbelen JH, Verhey FR, Bor JH, de Bie RA, Koopmans RT. **Passive movement therapy in patients with moderate to severe paratonia; study protocol of a randomised clinical trial (ISRCTN43069940).** BMC Geriatr 2007;7(1):30.
18. Waardenburg H, Elvers W, Van Vechgel F, Oostendorp R. **Can paratonia be measured reliably? Evaluation of the reliability of a visual analogue scale and the modified tonus scale of Ashworth for measuring paratonia.** Nederlands Tijdschrift voor Fysiotherapie 1999;102(2):30-35.

19. Fuchs-Lacelle S, Hadjistavropoulos T. **Development and preliminary validation of the pain assessment checklist for seniors with limited ability to communicate (PACSLAC).** Pain Manag Nurs 2004;5(1):37-49.

20. Zwakhalen SM, Hamers JP, Abu-Saad HH, Berger MP. **Pain in elderly people with severe dementia: a systematic review of behavioural pain assessment tools.** BMC Geriatr 2006;6:3.

21. Zwakhalen SM, Hamers JP, Berger MP. **Improving the clinical usefulness of a behavioural pain scale for older people with dementia.** J Adv Nurs 2007;58(5):493-502.

22. Schneider LS, Olin JT, Doody RS, et al. **Validity and reliability of the Alzheimer's Disease Cooperative Study-Clinical Global Impression of Change.** The Alzheimer's Disease Cooperative Study. Alzheimer Dis Assoc Disord 1997;11 Suppl 2:S22-32.

23. Beurskens AJ, de Vet HC, Koke AJ. **Responsiveness of functional status in low back pain: a comparison of different instruments.** Pain 1996;65(1):71-76.

24. Reisberg B, Ferris SH, de Leon MJ, Crook T. **The Global Deterioration Scale for assessment of primary degenerative dementia.** American Journal of psychiatry 1982;139:1136-1139.

25. Tan FES. **Best Practices in analysis of longitudinal data.** In: Osborne J, ed. Best practices in quantitative methods. Thousand Oaks, CA: Sage Publisher inc., 2008:451-470.

26. Altman DG, Schulz KF, Moher D, et al. **The revised CONSORT statement for reporting randomized trials: explanation and elaboration.** Ann Intern Med 2001;134(8):663-694.

27. Brooks SV, Faulkner JA. **The magnitude of the initial injury induced by stretches of maximally activated muscle fibres of mice and rats increases in old age.** J Physiol 1996;497 (Pt 2):573-580.

28. Roman GC, Tatemichi TK, Erkinjuntti T, et al. **Vascular dementia: diagnostic criteria for research studies.** Report of the NINDS-AIREN International Workshop. Neurology 1993;43(2):250-260.

29. McKeith IG, Ballard CG, Perry RH, et al. **Prospective validation of consensus criteria for the diagnosis of dementia with Lewy bodies.** Neurology 2000;54(5):1050-1058.

8

General Discussion

Author:
Hans Hobbelen

Introduction

Paratonia, a progressive increase of muscle tone in dementia, puzzles many clinicians in daily practice. Although paratonia was already described a century ago, it never gained much scientific interest.[1] With this thesis I tried to elucidate the phenomenon of paratonia and this thesis hopefully will act as a catalyst for further research in this field.

The incitement for this thesis has been my personal daily struggle as a physiotherapist with patients in the most severe stages of dementia. In chapter 1 I formulated four aims of this thesis; 1) the development of a valid description of paratonia, 2) the development of a diagnostic tool for clinicians in daily practice, 3) point out factors of influence in the development of paratonia and 4) answering the question whether PMT has any beneficial effect on paratonia in the last stages of dementia.

This chapter provides an overview of the main findings of our research after which the methodological strengths and limitations will be discussed. Finally and most importantly, the clinical implications of our findings will be discussed.

Main findings

After four Delphi rounds (Chapter 3) with national and international experts in the field the following consensus definition of paratonia emerged:

Paratonia is a form of hypertonia with an involuntary variable resistance during passive movement. The nature of paratonia may change with progression of the dementing illness (e.g. Active assistance (also known as Mitgehen) is more common early in the course of degenerative dementias, whilst active resistance is more common later in the course of the disease). The degree of resistance varies depending on the speed of movement (e.g. low resistance to slow movement and high resistance to fast movement). The degree of paratonia is proportional to the amount of force applied. Paratonia increases with progression of dementia. Furthermore, the resistance to passive movement is in any direction and there is no clasp-knife phenomenon.[2]

This definition of paratonia has been the foundation for the development of an assessment tool to diagnose paratonia in daily practice (Chapter 4). The Paratonia Assessment Instrument (PAI) appeared to be a valid, reliable and feasible tool in daily practice to diagnose paratonia and to distinguish it from Parkinson's rigidity and spasticity after stroke.[3] The PAI is an assessment instrument by which an examiner can establish the presence of paratonia by moving subsequently all four limbs passively in flexion and extension with the participant in a sitting position. The examiner starts with a slow movement of the limb after which the movement is accelerated.

Paratonia is present when the assessor is positive about all 5 criteria of the PAI: *there is an involuntary variable resistance, the degree of resistance varies depending on the speed of*

movement (e.g. a low resistance by slow movement and a high resistance by fast movement), the resistance to passive movement can be in any direction, there is no clasp-knife phenomenon and the resistance is felt in 2 movement directions in 1 limb or in 2 different limbs.
If the examiner feels a resistance that is not influenced by the speed of the movement, it is more likely that this is caused by Parkinsonian rigidity (lead pipe phenomenon). If the examiner feels the resistance only in one movement direction, in 1 limb or with a clasp-knife phenomenon than a spasm after stroke is more likely to be the problem.

With the PAI we were able to investigate possible contributing factors in the development of paratonia in a large cohort of 204 dementia patients, who were not yet in the advanced stages of the disease (Chapter 5). This 1-year longitudinal study showed that patients with paratonia had in general higher Global Deterioration Scale (GDS) rating (chi-square, $p<.01$), lower Mini Mental State Examination (MMSE) scores (scores: 15.4 versus 18.2; independent sample t-test $p < .01$) and worse Timed Up and Go (TUG) (Cross tabulation chi-square $p< .01$).[4, 5] This indicates that the functional mobility of patients with paratonia is worse (indicated by the TUG) and that they are in a more advanced stage of the dementia (indicated by the GDS and the MMSE). Furthermore, we discovered that Diabetes mellitus is a major contributing factor in the development of paratonia. Participants with DM had an almost 11-fold higher chance to develop paratonia in a year's time. This is a novel finding and we can only hypothesize about what causes this effect. Two options are most likely to be of influence, first, the effect that high levels of glucose causes nonenzymatic glycation with advanced glycation endproducts (AGE) forming cross links in collagen that causes stiffening of all tissues, a process normally seen in ageing yet accelerated by DM. The second is the negative effect DM has on the vascular system. That vascular damage possibly plays a role in the development of paratonia can also be seen in the Hazard ratio of 3.1 in Vascular Dementia participants in 1-year's time.

Finally the results of the single blinded multi-centre randomized clinical trial showed that PMT has a negative effect on the muscle tone (Chapter 6 and 7), confirming our findings in the pilot study (Chapter 2). There was no indication of any positive effect on the patient's well-being or the carer's burden and therefore this intervention is not recommended. No alternatives have been investigated so far.

Strengths and limitations
In order of the subsequent aims I will discuss the strengths and limitations of our findings.
The major criticism on the pilot study (Chapter 2) was based on the fact that we had a very small sample-size with a very heterogeneous population in which it was even uncertain if they actually had paratonia.[6, 7]

To counter this criticism we initiated a Delphi procedure to realize a valid consensus definition of paratonia (Chapter 3). A Delphi procedure is a valid and accepted scientific method to establish a consensus between experts when there is a wide variety of descriptions/definitions/opinions/evidence about one topic.[8] After our literature search it was clear that this was the case with paratonia. Sound scientific research would have been impossible when there is still debate about the exact definition of paratonia. For this Delphi procedure, we considered acknowledged experts or authors of papers in which paratonia was either the subject or was contrasted with spasticity or rigidity as experts and possible participants. Unfortunately, recent literature was scarce: we therefore could only identify and reach 17 experts. The fact that 8 of them agreed to participate gives strength to the new consensus definition and content validity can be assumed.
For further research purposes and for giving clinicians a valid, reliable and feasible tool to diagnose paratonia, we used the new consensus definition of paratonia as the foundation for the development of the Paratonia Assessment Instrument (PAI) (Chapter 4). The main limitation in this study is undoubtedly the translations back and forth from English to Dutch. The consensus definition was established in English. However, since the main studies for this thesis were done in the Netherlands, this has been translated into Dutch and processed into an assessment instrument. The final version of the instrument has been translated back into English for publication. The validity of the PAI can be compromised in this way.

The remarkable finding that DM is a predictive factor in the development of paratonia in our 1-year longitudinal research is interesting (Chapter 5). Paratonia has never been previously prospectively and longitudinally investigated, and with the new definition and assessment tool we were able to give insight into the presence and development of paratonia in a cohort of 204 dementia patients. Although we investigated this in a large cohort, it was unfortunately a heterogeneous group with participants in 4 different stages of dementia. Furthermore, we have to acknowledge that there is a possibility that the PAI is not able to distinguish between the stiffness caused by advanced glycation endproducts and mild paratonia by which the importance of DM as risk factor can be overestimated. Further longitudinal research, with a longer follow-up period, is necessary to unravel the contribution of DM to the development of paratonia.

Finally, we conducted a multi-centre randomized clinical trial to investigate the effect of passive movement therapy in a larger and more homogeneous research population than we investigated in the pilot study. Our power analysis indicated that we needed 138 participants for this trial, yet with 110 we did not reach this number. Nevertheless, given the fact that there is a negative trend visible in those participants who received PMT, it is even more debatable if it would have been ethical to proceed and reach the target numbers. An additional 28

participants could have modified this negative trend, but it is not to be expected that it would have turned into a positive one. Given the fact that the main goal of PMT is to subdue the high muscle tone and improve daily care, no effect is still negative in this perspective.
A limitation in the RCT was surely the small number of participants per institution, although the PMT protocol and all assessments were intensively practiced at all locations to ensure a high level of standardization. A major strength of this research is that it was a pragmatic multi-centre trial, performed in the real setting with physical therapists and nurses dealing with the problems of paratonia every day. It is well known that these kinds of trials are a struggle between internal and external validity. [9] Limiting the inclusion criteria and optimizing randomization are used for realizing both. In contrast with most pragmatic trials we also realized blinding of all assessors. This construct of pragmatic trials enabled all therapists to make pragmatic decisions with, for example, a sudden change of the treatment days to ensure 3 treatments a week and the assessments on the right day.

All research conducted for this thesis has been performed without any substantial funding. To enable this research it was necessary to find nursing homes and dementia day care units who recognized the problems investigated and were enthusiastic to participate without any financial compensation. Although not likely, this can have caused selection bias in all studies with only those nursing homes and dementia day care units participating with the most problematic population or the most eager physiotherapists to prove the negative or positive effects of PMT. In the study designs we anticipated on this problem and are convinced that this had no effect on the main outcomes of this thesis. However, to enlarge their commitment we designed our research close to daily practice, recognizable for all participants with the advantage of improving the external validity because it enhances the applicability of the final results. The disadvantage was that it proved to be very difficult to convince funders of the importance of this specific and specialized physiotherapeutic topic. It can be that the intended purpose of our studies and our specific design decisions, more pragmatic than explanatory, were not adequately reported and therefore not assessed correctly by funders.[10] To help trial designers Thorpe et al. developed in 2009 a specific tool, the pragmatic-explanatory continuum indicator summary (PRECIS), by which research funders can understand better the research intentions. [10] This development is of great importance because, although in Randomized Clinical Trials the risk of bias is minimized, the applicability of the trial's results are difficult to interpret for clinicians in daily practice. [11]

Clinical implication

In the light of Evidence-Based Practice (EBP) in psychogeriatric care and physiotherapy, this thesis can be seen as a small, yet important contribution.

The multi-centre randomized clinical trial resulted in a confirmation that PMT has no beneficial effect for the patient or the carer. This can be seen as a negative result and possibly even as negative for physical therapy in itself. However, proving that a therapy is not effective creates openness to improve daily care and gives the clinician's arguments towards concerned relatives and carers the opportunity to look for alternatives. Eventually improving the efficiency of psychogeriatric and physiotherapeutic care.
EBP is based on four pillars: 1) scientific evidence, 2) patient's circumstances, 3) the patient's preferences and 4) the clinical expertise to integrate the previous components. [12] The third pillar, the patient's preferences, is severely compromised by cognitive decline of the patient. Most often the partner or children assume responsibility for this role of the patient in this process yet this holds difficulties in interpretation too. [13, 14]Information of the best evidence should therefore not only be easily available for clinicians but also translated into laymen's language.

Implementation of the results concerning PMT is expected to be, in the Dutch situation anyhow, not a difficult job because many colleagues were already in doubt about the effect of PMT in these frail patients. However, there are still some die-hards who are convinced of the positive effect of PMT. I hope they will take notice of this research and are stimulated to look from a new perspective towards the treatment they are giving and stay open for debate about the detrimental effects of PMT.[15-17]
I realize that this research gives no alternative intervention in the most problematic last stages of dementia in which paratonia has such a devastating effect. With the development of the new description and the PAI clinicians have gained a tool by which they can distinguish between different muscle tone disorders that can be present in these stages, offering them a possibility for a better differential diagnosis and widening their perspective in possible interventions. Until now, especially in the advanced stages of dementia, all forms of hypertonia were named paratonia or classified as Extrapyramidal. This classification, however, is treated by Kurlan et al. as obsolete because it gives no concrete indication of the real disturbance.[18] For a better understanding of the pathogenesis and the possible treatment of it, it is important to objectify the differences in the quality of the movement disorders seen in dementia. The implementation of this tool must therefore be actively promoted.

At the beginning of this paratonia project little was known about the development of paratonia. Paratonia had been linked with substantia nigra pathology and dysfunction of the frontal lobes.[19-28] Our pilot study (Chapter 2), with a worsening of paratonia in the PMT group, indicated that possibly biomechanical factors played also a role in the development of paratonia.[29] The finding that DM is a major risk factor and vascular damage a possible contributing factor is a most promising result from our longitudinal research. Additionally this

research indicated that we can detect early stage paratonia when dementia patients show a decline in their functional mobility (Chapter 5). This knowledge enables clinicians to identify in earlier stages of dementia who is at risk to develop paratonia and possibly administer preventive interventions to prevent further increase of paratonia. For now the well-known preventive interventions targeted at the long-term negative effects of DM and of cardiovascular fitness are a serious option although the effect in the long term to prevent paratonia is as yet unknown.[30, 31] Future research should focus on this.

References

1. Dupré E. **Débilité mentale et débilité motrice associées.** Rev Neurol. 1910;20: 54-56.
2. Hobbelen JS, Koopmans RT, Verhey FR, Van Peppen RP, de Bie RA. **Paratonia: a delphi procedure for consensus definition.** J Geriatr Phys Ther. 2006;29: 50-56.
3. Hobbelen JS, Koopmans RT, Verhey FR, Habraken KM, de Bie RA. **Diagnosing paratonia in the demented elderly: reliability and validity of the Paratonia Assessment Instrument (PAI).** Int Psychogeriatr. 2008;20: 840-852.
4. Podsiadlo D, Richardson S. **The timed "Up & Go": a test of basic functional mobility for frail elderly persons.** J Am Geriatr Soc. 1991;39: 142-148.
5. Reisberg B, Ferris SH, de Leon MJ, Crook T. **The Global Deterioration Scale for assessment of primary degenerative dementia.** American Journal of psychiatry. 1982;139: 1136-1139.
6. Branten J. **Effect of passive movement on severity of paratonia:a partially blinded, randomized clinical trial- letter to the editor.** Nederlands Tijdschrift voor Fysiotherapie. 2004;114: 55.
7. Van de Rakt J. **Effect of passive movement on severity of paratonia:a partially blinded, randomized clinical trial- letter to the editor.** Nederlands Tijdschrift voor Fysiotherapie. 2004;114: 55.
8. McKenna HP. **The Delphi technique: a worthwhile research approach for nursing?** J Adv Nurs. 1994;19: 1221-1225.
9. Godwin M, Ruhland L, Casson I, et al. **Pragmatic controlled clinical trials in primary care: the struggle between external and internal validity.** BMC Med Res Methodol. 2003;3: 28.
10. Thorpe KE, Zwarenstein M, Oxman AD, et al. **A pragmatic-explanatory continuum indicator summary (PRECIS): a tool to help trial designers.** J Clin Epidemiol. 2009;62: 464-475.
11. Treweek S, Zwarenstein M. **Making trials matter: pragmatic and explanatory trials and the problem of applicability.** Trials. 2009;10: 37.
12. Haynes RB. **What kind of evidence is it that Evidence-Based Medicine advocates want health care providers and consumers to pay attention to?** BMC Health Serv Res. 2002;2: 3.
13. Gevers S. **Dementia and the law.** Eur J Health Law. 2006;13: 209-217.
14. Wrigley A. **Proxy consent: moral authority misconceived.** J Med Ethics. 2007;33: 527-531.
15. Haynes RB, Haynes GA. **What does it take to put an ugly fact through the heart of a beautiful hypothesis?** Evid Based Med. 2009;14: 68-69.
16. Grol R, Wensing M. **What drives change? Barriers to and incentives for achieving evidence-based practice.** Med J Aust. 2004;180: S57-60.
17. Glasziou P, Haynes B. **The paths from research to improved health outcomes.** ACP J Club. 2005;142: A8-10.
18. Kurlan R, Richard IH, Papka M, Marshall F. **Movement disorders in Alzheimer's disease: more rigidity of definitions is needed.** Mov Disord. 2000;15: 24-29.
19. Bennett HP, Corbett AJ, Gaden S, Grayson DA, Kril JJ, Broe GA. **Subcortical vascular disease and functional decline: a 6-year predictor study.** J Am Geriatr Soc. 2002;50: 1969-1977.
20. Beversdorf DQ, Heilman KM. **Facilitory paratonia and frontal lobe functioning.** Neurology. 1998;51: 968-971.

21. Chatterjee A. **Feeling frontal dysfunction: facilitory paratonia and the regulation of motor behavior.** Neurology. 1998;51: 937-939.

22. Franssen EH, Kluger A, Torossian CL, Reisberg B. **The neurologic syndrome of severe Alzheimer's disease. Relationship to functional decline.** Arch Neurol. 1993;50: 1029-1039.

23. Gladstone DJ, Black SE. **The Neurological Examination in Aging, Dementia and Cerebrovascular Disease.** part 2: Motor Examination. geriatrics and ageing. 2002;5: 44-49.

24. O'Keeffe ST, Kazeem H, Philpott RM, Playfer JR, Gosney M, Lye M. **Gait disturbance in Alzheimer's disease: a clinical study.** Age Ageing. 1996;25: 313-316.

25. Paulson G, Gottlieb G. **Development reflexes: the reappearance of foetal and neonatal reflexes in aged patients.** Brain. 1968;91: 37-52.

26. Risse SC, Lampe TH, Bird TD, et al. **Myoclonus, seizures, and paratonia in Alzheimer disease.** Alzheimer Dis Assoc Disord. 1990;4: 217-225.

27. Souren LE, Franssen EH, Reisberg B. **Neuromotor changes in Alzheimer's disease: implications for patient care.** J Geriatr Psychiatry Neurol. 1997;10: 93-98.

28. Tyrrell P, Rossor M. **The association of gegenhalten in the upper limbs with dyspraxia.** J Neurol Neurosurg Psychiatry. 1988;51: 995-997.

29. Hobbelen J, de Bie R, van Rossum E. **Effect of passive movement on severity of paratonia:a partially blinded, randomized clinical trial.** Nederlands Tijdschrift voor Fysiotherapie. 2003;113: 132-137.

30. Chodzko-Zajko WJ, Proctor DN, Fiatarone Singh MA, et al. **American College of Sports Medicine position stand. Exercise and physical activity for older adults.** Med Sci Sports Exerc. 2009;41: 1510-1530.

31. Sigal RJ, Kenny GP, Wasserman DH, Castaneda-Sceppa C, White RD. **Physical activity/exercise and type 2 diabetes: a consensus statement from the American Diabetes Association.** Diabetes Care. 2006;29: 1433-1438.

Summary

Chapter 1 gives an overview of the history behind this thesis. Paratonia is a distinctive muscle-tone disorder in late stage dementia that, although already noticed and described in 1910, never gained much scientific interest. Paratonia is noted to be of importance in the decline of the quality of life and results in an exponential increase of the carer's burden in the final stages of dementia. The prevalence of paratonia is estimated on 10% in the early stages towards 90% in the final stages of dementia. In the international literature exists a wide variety of descriptions and limited hypotheses about the origin of paratonia. Passive movement therapy (PMT) is one of the main interventions administered by physiotherapists in Dutch nursing homes to reduce the muscle tone and sustain the range of motion. Although carers claim that this therapy is beneficial physiotherapists have some doubts about the efficacy and this was the main reason to increase the insight into Paratonia. For this we formulated four aims;
(1) The realization of a valid description of paratonia.
(2) To give the clinician a tool for diagnosing paratonia by which differentiation with other muscle tone disorders can be established.
(3) To point out factors that influence the development and severity of paratonia.
(4) To answer the question if PMT has any beneficial effect on the severity of paratonia in late stage dementia patients.

Chapter 2 describes a Pilot Randomized Clinical Trial investigating the effect of passive movement therapy in severe paratonia compared with good stabilizing cushions and a control group. This randomised clinical trial involved residents of the psychogeriatric unit of the 'De Weerde' nursing home in Eindhoven, the Netherlands. Participants were randomised over three groups: group 1 received three sessions of PMT per week, group 2 used supporting cushions, and group 3 acted as a control group. Nine treatment sessions were given, and subjects were evaluated before and after each session using a modified Ashworth scale for measuring severity of paratonia. All four limbs were assessed in four movement directions (flexion, extension, abduction, and adduction). After screening and proxy consent fifteen patients were included, five in each group. Supporting cushions were most beneficial for both arms after three weeks of treatment, and for flexion of both legs after one treatment session (not significant). Trend analyses showed that PMT appears to be beneficial after one treatment, which supports carers' claims of a positive effect. However, the long-term effects of PMT were questionable.

Chapter 3 describes a Delphi procedure to establish an international consensus definition. The Delphi procedure involved an anonymous and multi-stage approach presented as a questionnaire, with each stage building on the results of the previous one. Eight out of 17 identified and addressed experts agreed to participate. The questionnaire was divided into three categories: commonly used descriptions, influencing factors, and features that can

differentiate between paratonia, parkinson's rigidity and spasticity. After four rounds the participants reached consensus on the importance of 4 short descriptions, 4 influencing factors and 2 differentiating elements which was compiled to one description of paratonia. Paratonia is a form of hypertonia with an involuntary variable resistance during passive movement. The nature of paratonia may change with progression of the dementing illness (e.g. Active assistance (also known as Mitgehen) is more common early in the course of degenerative dementias, whilst active resistance is more common later in the course of the disease). The degree of resistance varies depending on the speed of movement (e.g. Low resistance to slow movement and high resistance to fast movement). The degree of paratonia is proportional to the amount of force applied. Paratonia increases with progression of dementia. Furthermore, the resistance to passive movement is in any direction and there is no clasp-knife phenomenon.

Chapter 4 describes the transformation of the new consensus definition towards a feasible assessment instrument. For this we used a three-phase cross-sectional survey. In the first two phases, the Paratonia Assessment Instrument (PAI) was developed and validated. In the third phase, the inter- observer reliability and feasibility of the instrument was tested. Inter-observer reliability between the two assessors resulted in an improvement of Cohen's κ from 0.532 in the initial phase to 0.677 in the second phase. Two independent assessors validated this improvement in the third phase with Cohen's κ ranging from 0.625 to 1.
The definite PAI is a construct of five criteria representing distinct elements of the clinical manifestation of paratonia. The presence of paratonia can be established by conducting passive movement of the shoulders, elbows and hips through flexion and extension while the patient is in a seated position. The five criteria that all need to be met in order to make the diagnosis of paratonia are: 1) there is an involuntary variable resistance,2) the degree of resistance varies depending on the speed of movement (e.g. a low resistance by slow movement and a high resistance by fast movement),3) the resistance to passive movement can be in any direction, 4) there is no clasp-knife phenomenon and 5) the resistance is felt in 2 movement directions in 1 limb or in 2 different limbs.

Chapter 5 describes a multi-centre longitudinal 1-year follow-up cohort study to investigate the prevalence, incidence and the risk factors of paratonia in dementia. Fit and mobile persons with dementia, scoring stage 6 or lower on the Global Deterioration Scale of Reisberg (GDS), were considered eligible for inclusion and were only included after written informed or proxy consent. They were enrolled from Dementia day-care centres of nursing homes and residential homes with dementia special care units (DCUs) in the regions Eindhoven, Helmond and Tilburg in the Netherlands.

Participants were assessed with the Paratonia Assessment instrument (PAI) as our primary assessment instrument. The functional mobility was assessed with the Timed Up and GO (TUG)test, the quality of life with the Qualidem, the severity of dementia with the GDS of Reisberg, the cognitive function with the Mini Mental State Examination (MMSE) and the diagnosis of dementia, co-morbidities and the use of medication were obtained from the participants' medical dossier combined with the General Practitioners' (GP) files. The PAI was assessed every 3 months. All other variables were assessed at baseline and after 12 months.
Baseline measures were assessed in 204 participants, 111 (54%) female and 93 (46%) male with a mean age of 79.8 years (56-97). 71 (34.8%) were diagnosed with paratonia at baseline and 51 developed paratonia over one year. In the Vascular Dementia group the highest Hazard ratio (3.1) for developing paratonia in 1-year time was found and one of the highest prevalences at baseline (42%).
Logistic regression analysis revealed that one unit lower on the MMSE (OR= .90) and Diabetes Mellitus (OR=10.7) were significantly related to the development of paratonia (Wald chi square p-value <.01). We concluded that DM is a significant risk factor for the development of paratonia as well as probably vascular damage.

Chapter 6 describes the study protocol of a Multicentre Randomized Clinical Trial (RCT) to investigate the effect of passive movement therapy (PMT) on the severity of paratonia and on the improvement of daily care.
A RCT with a 4-week follow-up is proposed with dementia patients with moderate to severe paratonia. Patients are only included after proxy consent. With computerized and concealed block randomization (block size of 4) patients are included in one of two groups. The first group receives PMT, the second group receives usual care without PMT. In this chapter an extensive account is given on how PMT should be administered. The study protocol prescribes PMT by a physiotherapist three times a week for four weeks in a row. The main outcome measure is the Modified Ashworth scale to assess the severity of paratonia. To assess the improvement on daily care we introduced in this study protocol as secondary outcome measures the Clinical Global Impressions (CGI) and a modified version of the Patient Specific Complaints (PSC). Furthermore, to assess a decrease of pain during daily care as a possible side-effect of PMT the Pain Assessment Checklist for Seniors with Limited Ability to Communicate, Dutch version (PACSLAC-D), is proposed. Data collection will be at baseline shortly before the first treatment, after two weeks one day after to the 6th treatment and after four weeks one day after the 12th and final treatment. Sample size calculations are based on the analyses of the pilot study (chapter 2) and indicate a sample size of 69 patients per group. This chapter ends with a proposal for the statistical analyses.

Chapter 7 describes the results of the multicentre Randomized Clinical Trial in 12 nursing homes across the Netherlands. A total of 102 patients participated and data of 101 participants were analysed. Data collection took place between April 2007 and April 2009.
Of the participants 82.2% (n=83) were female. The mean age was 84 years (range 67-98 years) and most of the participants (65.3%, n=66) were in the most severe stage of dementia GDS 7 and 34.7% (n=35) in GDS 6 stage. Sixty-three percent (n=64) had Alzheimer dementia (AD), 18% (n=18) had vascular dementia (VaD), 11% (n=11) a combination of AD and VaD, 4% (n=4) had a diagnosis of Lewy Body dementia and in 4% (n=4) of patients dementia was not otherwise specified.
The Ashworth score was analysed with mixed effects linear models on three levels, time level nested within patient level nested within institution.
This procedure was also used in the analysis of the PACSLAC-D and the PSC. To account for the dependency of the three subsequent questions about the carer's strain of the PSC these data have been fully cross-classified with time at first level.
In all analyses we accounted for the differences of the different types and stages of dementia, the baseline assessments and a natural time effect. In order to test if PMT has a different effect in the different nursing homes, the different types of dementia or stages of the disease, we entered these factors as interaction terms in the models. Finally the CGI has been analysed with cross-tabulation chi-square.
This study found that PMT does not decrease muscle tone but shows a trend towards worsening of joint and limb stiffness compared with controls. Although not statistically significant, we found it clinically very relevant because this therapy is meant to reduce the muscle tone. Furthermore, there is no indication that the carer's strain decreases as a consequence of PMT. PMT is therefore not recommended as an intervention in severe paratonia

Chapter 8, the general discussion, gives an overview of the main results of this thesis and the methodological strengths and limitations of the subsequent studies. Furthermore, it discusses the clinical implications of the main findings and gives recommendations for further research.

Samenvatting

Hoofdstuk 1 geeft inzicht in de ontwikkeling van dit proefschrift. Paratonie is een karakteristieke tonus stoornis in het laatste stadium van dementie. Ondanks het feit dat paratonie al in 1910 is beschreven is er toch weinig wetenschappelijke aandacht voor geweest. Paratonie speelt echter een belangrijke rol in de achteruitgang van de kwaliteit van leven en zorgt voor een exponentiële toename van de zorgzwaarte in de laatste fase van dementie. De prevalentie van paratonie wordt geschat op 10% in de beginstadia van dementie en loopt op tot liefst 90% in de laatste fase. Er is een grote variatie in de beschrijvingen van paratonie te vinden in de internationale literatuur en een beperkt aantal hypothesen over de pathogenese. Passief mobiliseren (PMT) met als doel de spierspanning te reduceren en de mobiliteit te handhaven is één van de meest toegepaste interventies door fysiotherapeuten in de Nederlandse verpleeghuizen. Ondanks dat de verzorging aangeeft dat deze therapie gunstige effecten heeft zijn er bij de fysiotherapeuten twijfels over de effectiviteit. Dit was de belangrijkste reden om het inzicht in paratonie te vergroten. Om dit te realiseren hebben we vier doelen gesteld:

(1) Het realiseren van een valide beschrijving van paratonie
(2) Het ontwikkelen van een instrument om paratonie te kunnen diagnosticeren en te differentiëren van andere spiertonus stoornissen
(3) Het vinden van factoren die de ontwikkeling en de ernst van paratonie kunnen beïnvloeden
(4) Het beantwoorden van de vraag of PMT gunstige effecten heeft op de ernst van paratonie in het laatste stadium van dementie.

Hoofdstuk 2 is de beschrijving van de pilot study waarin gekeken is naar het effect van passief mobiliseren (PMT) op ernstige paratonie in vergelijking met goed ondersteunende kussens en een controle groep. Deze gerandomiseerde klinische trial is uitgevoerd in verpleeghuis "De Weerde" in Eindhoven. De deelnemers werden at random ingedeeld in 1 van de 3 groepen; Bij groep 1 werd de interventie PMT drie keer per week toegepast, groep 2 kreeg goed ondersteunende kussens en groep 3 fungeerde als controle groep. In totaal werden negen behandelingen gegeven en de ernst van de paratonie werd bij de deelnemers voor en na elke behandeling met de Modified Ashworth scale geëvalueerd. Alle vier de ledematen werden in vier bewegingsrichtingen gemeten (flexie, extensie, abductie en adductie). Na screening en proxy consent zijn er 15 deelnemers geincludeerd, 5 in elke groep. Goed ondersteunende kussen hadden een gunstig effect voor beide armen na 3 weken en voor de flexie van beide benen na elke behandeling (niet significant). Een trend analyse gaf aan dat PMT een gunstig effect lijkt te hebben na elke behandeling, dit ondersteund de ervaren gunstige effecten door de verzorging. Echter de lange termijn effecten blijven onduidelijk.

Hoofdstuk 3 beschrijft de Delphi procedure waarmee een internationale consensus definitie tot stand is gekomen. De Delphi procedure is een techniek waarmee anoniem in een aantal fasen een vragenlijst wordt gepresenteerd. Elke fase bouwt voort op de voorafgaande fase. Acht van de zeventien geïdentificeerde en benaderde experts gingen akkoord met deelname. De vragenlijst was verdeeld in 3 categorieën; meest gebruikte beschrijvingen, factoren die de mate van paratonie beïnvloeden en mogelijke elementen die paratonie kunnen onderscheiden van rigiditeit bij m. Parkinson en spasticiteit. Na 4 ronden bereikten de deelnemers consensus over 4 korte beschrijvingen, 4 beïnvloedende factoren en 2 onderscheidende elementen die van belang zijn voor een goede beschrijving van paratonie. Uiteindelijk is dit samengevoegd tot 1 consensus definitie; Paratonie is een vorm van hypertonie met een onvrijwillige variabele weerstand tegen passief bewegen. Met progressie van de dementie kan de uitingsvorm van paratonie veranderen (van actief meebewegen (ook bekend als 'Mitgehen') in het begin van de ziekte naar actief tegenbewegen in de latere stadia). De mate van weerstand is afhankelijk van de snelheid van bewegen (langzaam bewegen geeft weinig weerstand, snel bewegen geeft veel weerstand). De mate van weerstand is afhankelijk van de kracht die door de onderzoeker wordt gebruikt. En de weerstand kan in elke bewegingsrichting voelbaar zijn en er is geen knipmesfenomeen.

In **Hoofdstuk 4** wordt de transformatie beschreven van de nieuwe consensus definitie naar een goed toepasbaar diagnostisch instrument. Hiervoor is een 3 fasen cross-sectioneel onderzoek verricht. Het Paratonia Assessment Instrument (PAI) is in de eerste twee fasen ontwikkeld en gevalideerd. In de derde fase is de inter-beoordelaars betrouwbaarheid getoetst alsmede de toepasbaarheid van het instrument. Inter- beoordelaars betrouwbaarheid tussen de twee meters was in de eerste fase Cohen's κ 0.532 en verbeterde in de tweede fase naar Cohen's κ 0.677. Twee onafhankelijke meters valideerde deze betrouwbaarheid in de derde fase met Cohen's κ tussen 0.625 en 1. Het definitieve diagnostische instrument PAI bestaat uit 5 specifieke criteria die elk een karakteristieke eigenschap van paratonie vertegenwoordigen. De aanwezigheid van paratonie kan vastgesteld worden door het uitvoeren van een eenvoudig bewegingsonderzoek bij een patiënt in zit door middel van de schouders, ellebogen en de heupen in flexie en extensie langzaam en snel te bewegen. Er is sprake van paratonie als alle vijf de volgende criteria aanwezig zijn; 1) Er is een onvrijwillige variabele weerstand tegen passief bewegen. 2) De mate van weerstand is afhankelijk van de snelheid van bewegen (langzaam bewegen, weinig weerstand en snel bewegen, veel weerstand). 3) De weerstand kan in elke richting gevoeld worden. 4) er is geen knipmesfenomeen. 5) de weerstand wordt gevoeld in 2 bewegingsrichtingen in 1 ledemaat of in 2 verschillende ledematen.

In **Hoofdstuk 5** wordt een multi-center longitudinale cohort study met 1 jaar follow-up beschreven waarin de prevalentie, incidentie en de risico factoren voor paratonie bij dementie onderzocht zijn. Voor dit onderzoek werd gezocht naar fitte en mobiele personen met dementia, in stadium 6 of lager op de Global Deterioration Scale van Reisberg. De mensen mochten alleen deelnemen aan het onderzoek als ze ook het informed consent of proxy consent formulier hadden ondertekend. De potentiële deelnemers werden gezocht in psychogeriatrische dagbehandelingen van verpleeghuizen en verzorgingshuizen of speciale psychogeriatrische afdelingen in verzorgingshuizen in de regio's Eindhoven, Helmond en Tilburg.
De Paratonia Assessment Instrument (PAI) om paratonie te kunnen vaststellen was het voornaamste meetinstrument wat bij alle deelnemers werd gebruikt. Daarnaast werd de functionele mobiliteit met de Timed Up and GO (TUG)test gemeten. De kwaliteit van leven met de Qualidem, de ernst van de dementie met de GDS van Reisberg, het cognitief verval met de Mini Mental State Examination (MMSE) en de diagnose van dementie, overige aandoeningen en het medicijn gebruik werd uit het op de afdeling aanwezige medische dossier gehaald en aangevuld met gegevens van de huisarts. De PAI werd elke 3 maanden afgenomen en alle andere variabelen werden bij de start van het onderzoek en op het eind, na 12 maanden, getest.
Bij de start van het onderzoek zijn 204 deelnemers getest, 111 (54%) vrouwen en 93 (46%) mannen met een gemiddelde leeftijd van 79,8 jaar (56-97). Bij 71 (34,8%) werd paratonie vastgesteld. In de loop van het jaar ontwikkelde zich paratonie bij 51 deelnemers. De groep met Vasculaire Dementie had de hoogste Hazard Ratio (3.1) om paratonie te ontwikkelen in 1 jaar en bovendien werd in deze groep één van de hoogste prevalenties gemeten bij de start van het onderzoek (42%).
Logistische regressie liet zien dat 1 punt lager op de MMSE (OR=.90) en Diabetes Mellitus (OR=10.7) beide significante factoren zijn voor het ontwikkelen van paratonie (Wald chi square p-waarde <.01). De conclusie uit dit onderzoek was dat DM een significante factor is in de ontwikkeling van paratonie en wellicht ook vasculaire schade.

In **Hoofdstuk 6** wordt het studie protocol beschreven om het effect van passief mobiliseren (PMT) op de ernst van paratonie en op de verzorgbaarheid te onderzoeken door middel van een multi-centre gerandomiseerde klinische trial (RCT). Er wordt hierin een RCT voorgesteld met een follow-up van 4 weken waarbij patiënten met matig tot ernstige paratonie kunnen deelnemen. De patiënten worden alleen geincludeerd als er sprake is van proxy consent. Door middel van een computerprogramma vindt er een geblindeerde block-randomisatie plaats (block-size van 4) waarbij de deelnemers worden verdeeld in 2 groepen. Groep 1 krijgt de behandeling PMT en groep 2 krijgt de gewone dagelijkse zorg zonder PMT. In dit hoofdstuk wordt de werkwijze van PMT uitgebreid beschreven. Het onderzoeksprotocol schrijft

voor dat PMT 3 keer per week, 4 weken lang, door een fysiotherapeut wordt gegeven. De belangrijkste uitkomstmaat is de gemodificeerde Ashworth schaal (MAS) waarmee de ernst van de paratonie in kaart gebracht kan worden. De verbeteringen in verzorgbaarheid wordt in kaart gebracht door middel van de Klinische Globale impressie schaal (CGI) en een voor dit onderzoek gemodificeerde versie van de Patiënt specifieke klachten lijst (PSK, afgekort in het Engels als PSC). Verder wordt de Pain Assessment Checklist for Seniors with Limited Ability to Communicate, Dutch version (PACSLAC-D) ingezet om een afname van de pijn, een mogelijk neven effect van PMT, gedurende de ochtendzorg te observeren. De metingen vinden plaats bij de start van het onderzoek kort voor de eerste behandeling, na twee weken 1 dag na de 6de behandeling en na 4 weken 1 dag na de 12de behandeling. Het noodzakelijk aantal deelnemers (sample-size) is berekend aan de hand van de gegevens uit de pilot studie (Hoofdstuk 2) en komt uit op 69 patiënten per groep. Dit hoofdstuk eindigt met een voorstel voor de statistische analyse.

In **Hoofdstuk 7** worden de resultaten gepresenteerd van de multi-centre gerandomiseerde klinische trial in 12 Nederlandse verpleeghuizen. In totaal hebben 102 patiënten deelgenomen en zijn de meetgegevens van 101 deelnemers geanalyseerd. De gegevens zijn verzameld tussen april 2007 en april 2009.
82,2% (n=83) van de deelnemers was vrouw. De gemiddelde leeftijd was 84 jaar (range 67-98) en de meeste deelnemers bevonden zich in de laatste en ernstigste fase van dementie GDS 7 (65,3%, n=66). Het merendeel van de deelnemers had de diagnose ziekte van Alzheimer (AD) (63%, n=64), 18% (n=18) vasculaire dementie (VaD), 11% (n=11) een combinatie van AD en VaD, 4% (4) de diagnose Lewy body dementie en in de overige 4% (n=4) was de diagnose dementie niet nader gespecificeerd.
De meetgegevens van de gemodificeerde Ashworth schaal werd geanalyseerd door middel van mixed effect lineair model op 3 niveaus, met tijd genest in het patiënt niveau dat weer genest was in het instituut niveau. Deze zelfde procedure is gebruikt voor de analyse van de PACSLAC-D gegevens en de PSK data. Bij deze laatste is de data op het eerste niveau volledig cross-classified om rekening te houden met de onderlinge afhankelijkheid van de 3 vragen. In de analyse is verder rekening gehouden met de meetgegevens bij de start van het onderzoek, de verschillende type en stadia van dementie en het natuurlijke tijdseffect. De verschillende verpleeghuizen en type en stadia van dementie zijn als interactie termen in het model verwerkt om te zien of deze factoren een rol speelden op het effect van PMT. Tot slot zijn de gegevens van de CGI door middel van kruis tabellen chi-kwadraat getoetst.
Het resultaat van dit onderzoek liet een trend zien van verergering van de stijfheid bij de deelnemers die PMT hadden gekregen in vergelijking met de controle groep en dus zeker geen vermindering van de spierspanning. Alhoewel dit niet statistisch significant was is deze bevinding wel degelijk klinisch relevant om dat de interventie juist bedoeld is om de

spierspanning te doen afnemen. Bovendien is er geen indicatie gevonden dat de zorgzwaarte afneemt door PMT. PMT wordt daarom afgeraden als interventie bij ernstige paratonie.

Tot slot in **Hoofdstuk 8,** de algemene discussie**,** wordt een overzicht gegeven van de belangrijkste bevindingen uit dit proefschrift en worden de methodologische sterke en zwakke punten besproken van alle onderzoeken. Dit hoofdstuk eindigt met een discussie over de implicaties van de belangrijkste bevindingen voor de dagelijkse praktijk en aanbevelingen voor vervolg onderzoek.

Dankwoord

Bij de start van dit promotieonderzoek, 7 jaar geleden, wist ik niet in welk avontuur ik me stortte. Nu op het einde van de reis kijk ik met een zeer tevreden gevoel terug want het was een prachtig avontuur waarin ik op plekken ben beland die ik van te voren nooit had kunnen bedenken en waarin ik zeer interessante en enthousiaste mensen heb ontmoet die me steeds weer verder hielpen.
Dit dankwoord kan echter niet anders beginnen dan met het bedanken van de twee mensen die me vanaf het begin hebben gesteund en geleerd hebben om altijd verder te kijken dan de horizon, mijn ouders Mies en Nelly Hobbelen. Het is in woorden niet goed uit te drukken hoe groot mijn dankbaarheid voor hun beide is.

Wetenschappelijk onderzoek en het schrijven van een proefschrift kan niet zonder de medewerking en hulp van heel veel mensen. Om te beginnen wil ik dank zeggen aan Herman Maassen, Anne Theunissen, Hettie Suurd, Charles Verschuren en mijn oud stagiaire, collega en mede student Pepijn Roelofs die begrepen dat mijn ambities verder gingen dan de fysiotherapie en mij in alle opzichten in het begin van mijn wetenschappelijke carrière hebben ondersteund. Daarnaast natuurlijk ook John Bergs en Ton van Gerwen van de Raad van Bestuur van de Vitalis WoonZorg Groep Eindhoven die voor mij het onmogelijke mogelijk maakte door te investeren in wetenschap, zonder hen had dit promotieonderzoek niet plaats kunnen vinden. Ook hun opvolgers in de raad van bestuur, Pink van Veen maar in het bijzonder Léon Rulkens wil ik danken voor hun steun tijdens het promotietraject.

Mijn collega's van verpleeghuis de Weerde; Greetje Schoots, Annemarie van den Boogaard, Nicole Roelofs, Alda Wuyts, Susanne Maas, Frederike Stevens, Hanneke Huisman en Patricia Wannemakers hebben me, ondanks een zeer hoge werkdruk, altijd gesteund en geholpen en ik ben ze daar zeer dankbaar voor.

Toen ik me in het begin van dit traject op de aanwezige literatuur stortte en dacht dat er nog wel een review mogelijk zou kunnen zijn met het voorhanden zijnde materiaal was Roland van Peppen meteen bereid om 'die paar artikelen' mede te beoordelen. Ondanks dat het veel meer werk werd dan hij had verwacht en er uiteindelijk jammer genoeg géén review kwam bleef hij toch vol enthousiasme meewerken aan het vervolg van mijn promotietraject met als uiteindelijke resultaat de Delphi-procedure. Roland bedankt hiervoor.
De Delphi-procedure was verder ook onmogelijk geweest zonder de bijdrage van Roger Kurlan, Valerie Pomeroy, Pippa Tyrrell, Louise Ada, Anjan Chatterjee, John Branten, Jan van de Rakt en Charles Verschuren.

Verpleeghuisarts in opleiding Kitty Habraken vond paratonie een interessant onderwerp om haar afstudeeronderzoek op te richten. Dagen, weken achtereen heeft ze patiënten

bewogen en getest en dat terwijl ik maar steeds beweerde dat artsen geen verstand van bewegen hebben. Ik ben haar dankbaar voor haar bijdrage aan de ontwikkeling van de PAI.

Bij het verdere vervolg van mijn promotietraject zijn zeer veel mensen betrokken geweest. Ik dank alle deelnemende patiënten en familie en alle verpleeghuizen en verzorgingshuizen en hun medewerkers die een bijdrage hebben geleverd aan het longitudinale onderzoek en/of de RCT; verpleeghuis het Zonnelied in Ammerzoden (Stichting Nieuwebrug), verpleeghuis het Parkhuis in Dordrecht, verpleeghuis Novawhere in Purmerend (Stichting de Zorgcirkel), verpleeghuis Sonnevanck in Harderwijk, verpleeghuis Liduina in Boxtel (Zorggroep Elde), verpleeghuis het Zonnehuis in Doorn (Quarijn), verpleeghuis Houtwijk in Den Haag, verpleeghuis Lingesteijn in Leerdam (Rivas), verpleeghuis Sancta Maria in Zevenbergen (Surplus), verpleeghuis Jan de Witkliniek in Bakel, Keijserinnedael in Helmond en Nieuwenhof in Deurne (Zorgboog), verpleeghuis Albert van Koningsbruggen in Utrecht (Axioncontinu), stichting de Wever in Tilburg, St Anna Zorggroep Ananz ouderenzorg in Geldrop en de SVVE in Eindhoven.

Daarnaast wil ik zeker nog in het bijzonder dank zeggen aan alle collega's van verpleeghuis Wissehaege, Peppelrode, Engelsbergen (de Strekdam) en Brunswijck van de Vitalis WoonZorg Groep Eindhoven voor hun steun en inzet.

Los van al deze stichtingen en zorggroepen wil ik graag nog een aantal mensen in het bijzonder danken voor hun inzet. Allereerst José van Lier die als verpleeghuisarts in opleiding mijn onderzoek zo interessant vond dat ze iedereen en alles binnen haar eigen organisatie, het Zonnelied in Ammerzoden, zo enthousiast maakte dat ze als eerste konden starten met de RCT en een vol jaar lang steeds weer nieuwe deelnemers aandroeg.
Anique Landré, Marline de Kraker, Vera Luijckx en Melanie Brooijmans wisten mij te vinden met hun vragen over passief bewegen en paratonie en waren meteen enthousiast om een eigen bijdrage te leveren aan de antwoorden. In mijn zoektocht naar meer verpleeghuizen voor de RCT kwam ik oud studiegenoot Harrie van de Meerendonk in Boxtel tegen en hij was meteen bereid om te kijken of er in zijn verpleeghuis mogelijkheden waren en even enthousiast reageerde Dorine Joosten in Bakel. En om uiteindelijk toch voldoende deelnemers te kunnen krijgen in de RCT waren mijn studenten Johan van Haaften, Lilian van Loon, Inge Pol, Remco Looijen en Marjan Doves aan de master opleiding fysiotherapie in de geriatrie aan de Hogeschool Utrecht van onschatbare waarde.

Hans Bor en later Frans Tan wil ik bedanken voor hun onuitputtelijke geduld met mij wat betreft de statistiek. Vooral de afgelopen 2 jaar heb ik zeer veel geleerd van Frans Tan die altijd maar weer geduldig mijn vele vragen beantwoordde. Ik vond het een bijzonder prettige samenwerking.

Zoals ik al schreef heeft dit avontuur me op verschillende plekken gebracht en ben ik steeds weer zeer enthousiaste en hulpvaardige mensen tegengekomen die ieder op zich een kleine of grote bijdrage hebben geleverd aan het uiteindelijke proefschrift, vaak alleen door geïnteresseerd te luisteren en prikkelende vragen te stellen. Zoals Mientje Meussen die de prachtige illustraties voor de PAI en dit proefschrift heeft gemaakt. Sytse Zuidema, Jacques Neyens, Boudewijn Kollen, Gert Kwakkel, Ria Nijhuis en Ivan Bautmans wil ik in het bijzonder danken voor hun interesse in mijn werk en steun en vertrouwen. Hans van Herwaarde die mij bij de masteropleiding fysiotherapie in de geriatrie aan de Hogeschool Utrecht betrok. Ina Bettman, Tiny Looijen, Janke Oosterhaven, Jaap Dronkers, Jaap Jansen en Jacqueline Outermans mijn directe collega's op de HU. En ook van de HU Mieke Klootwijk, Rob van Dolder, Roland van Peppen en Harriet Wittink.
Het bestuur van de Nederlandse Vereniging voor Fysiotherapie in de Geriatrie; Mieke van Gemert, Marije Lubbers, Mieke Koning, Judith Weijman, Remco Küh, Ronald Valk. Eefke Wind, mijn zeer enthousiaste collega van de congres commissie NVFG.
Kari Vehmaskoski en Tiina Kuukkanen van de JAMK University of applied sciences in Jyväskylä Finland.
Het Nederlands Paramedisch Instituut in de personen van Ria Wams, Yvonne Heerkens en Dorine van Ravensberg die in mij het vertrouwen hebben voor de toekomst.
Mijn oud studiegenoten aan de Universiteit Maastricht; Karin Postma, Walter van der Weegen, Ton Lenssen, Jan Willem de Bruin, Roland van Peppen en Roland van Grinsven.
En alle vrienden en familie die op een afstand mijn bezigheden in de gaten hielden en af en toe zorg droegen voor de nodige afleiding.

Uiteraard ook zeer veel dank aan Conny de Zwart, mijn steun en toeverlaat op de faculteit epidemiologie, voor wie de afgelopen 7 jaar geen vraag te veel was.

En zeer bijzondere dank aan de trojka van 3 hoogleraren die mij al die jaren met raad en daad hebben bijgestaan. Rob de Bie, Raymond Koopmans en Frans Verhey. Ik heb al die jaren met zeer veel plezier met jullie samengewerkt en ongelofelijk veel geleerd. Het was hartverwarmend hoeveel steun en vertrouwen jullie naar mij uitstraalden !

Tot slot wil ik de drie allerbelangrijkste vrouwen in mijn leven bedanken. Mijn twee kleine meisjes Marije en Hanne die er voor zorgen dat er altijd leven in de brouwerij is. En natuurlijk Saskia die me de afgelopen 7 jaar een echt thuis heeft gegeven waar ik mezelf kan en mag zijn en waardoor dit alles mogelijk werd. Dank.

About the author

Hans Hobbelen was born on January 9, 1965 in Best, the Netherlands. After graduating from high school (Bracbant Havo in Boxtel) in 1982 he began his study physiotherapy at the university of applied sciences in 's Hertogenbosch (School for physiotherapy, part of the University of applied sciences Eindhoven). After his graduation in 1987 he shortly worked in Skagaströnd Iceland after which he returned to the Netherlands and start working in September 1988 in nursing home 'de Weerde' in Eindhoven. In 1998 he started to study Human movement sciences at the Maastricht University and obtained his Master of Science degree in 2001. In December 2003 he started his PhD project on a part-time base. He combined his work as researcher in 2006 with a job as lecturer at the University of applied sciences Utrecht and stopped his work as physiotherapist in 2007. In September 2010 he started in a new position as senior scientist at the Dutch Institute of Allied Health Care in Amersfoort (Nederlands Paramedisch Instituut, NPI) in combination with his position at the university of applied sciences Utrecht.

Hans is member of the congress committee of the Dutch society of geriatric physiotherapists (Nederlandse Vereniging voor Fysiotherapie in de Geriatrie).

Hans is married to Saskia van Duren and has two daughters, Marije (6) and Hanne (4) and lives in Vught, The Netherlands.

List of Publications

de Vries, N.M., Staal, J.B., van Ravensberg, C.D., **Hobbelen, J.S.M.**, Rikkert, M.G.M.O., Sanden, M.W.G.N.-v., Outcome Instruments to Measure Frailty: A Systematic Review, Ageing Research Reviews (2010), doi:10.1016/j.arr.2010.09.001

Hobbelen H, Outermans J. The application of the Paratonia Assessment Instrument [De toepassing van het Paratonia Assessment Instrument]. Fysiopraxis 2009, 18 (9); 24-27. (in Dutch)

Van Selm A, **Hobbelen J**. An Evidenced based movement program in psychogeriatric care [Een evidence based beweegprogramma voor psychogeriatrische verpleeghuisbewoners. Verslag van een implementatietraject op de afdeling fysiotherapie van woonzorgcentrum De Archipel in Almere. Fysiotherapie en Ouderenzorg 2009, 23 (2):39-45. (in Dutch)

Hobbelen JS, Koopmans RT, Verhey FR, Habraken KM, de Bie RA: Diagnosing paratonia in the demented elderly: reliability and validity of the Paratonia Assessment Instrument (PAI). Int Psychogeriatr 2008, 20 (4):840-852.

Hobbelen JS, Verhey FR, Bor JH, de Bie RA, Koopmans RT: Passive movement therapy in patients with moderate to severe paratonia; study protocol of a randomised clinical trial (ISRCTN43069940). BMC Geriatr 2007, 7(1):30.

Hobbelen H, de Bie R: Paratonia; where we stand [Paratonie; de stand van zaken]. Fysiotherapie en Ouderenzorg 2007. 21(2):20-24. (in Dutch)

Hobbelen JS, Koopmans RT, Verhey FR, Habraken KM, de Bie RA: Diagnosing paratonia in the demented elderly: reliability and validity of the Paratonia Assessment Instrument (PAI). Int Psychogeriatr 2008, 20 (4):840-852.

Hobbelen JS, Koopmans RT, Verhey FR, Van Peppen RP, de Bie RA: Paratonia: a delphi procedure for consensus definition. J Geriatr Phys Ther 2006, 29(2):50-56.

Hobbelen JSM. Physiotherapy and Paratonia. [Paratonie en Fysiotherapie]. Stimulus; 2/2004. (in Dutch)

Hobbelen J, de Bie R, van Rossum E: Effect of passive movement on severity of paratonia:a partially blinded, randomized clinical trial. Nederlands Tijdschrift voor Fysiotherapie 2003, 113(6):132-137. (in Dutch)

Van Peppen R.P.S., Harmeling-van der Wel BC, Kollen BJ, **Hobbelen JSM**, Buurke JH, Halfens J, Wagenborg L, Vogel MJ, Berns M, Van Klaveren R, Hendriks HJM, Heldoorn M; Van der Wees PhJ; Dekker J; Kwakkel G. The effects of physiotherapeutic interventions in patients with stroke; a systematic review. [Effecten van fysiotherapeutische interventies bij patiënten met een beroerte: een systematisch literatuuronderzoek]. Ned Tijdschr Fysiother 2004;114(5):126-153. (in Dutch)

Contributions to Books;

Hobbelen H. Paratonia in Dementia; Diagnostics, Clinimetrics and treatment. [Diagnostiek, klinimetrie en behandeling van paratonie bij dementie]. In Jaarboek Fysiotherapie Kinesitherapie 2010, hoofdstuk 5;79-88. (in Dutch)

Submitted:

Hobbelen JS, Tan. F., Verhey FR, Koopmans RTCM, de Bie RA (2010). Passive Movement Therapy in Severe Paratonia: a Multi centre randomized clinical trial.

Hobbelen JS, Tan. F., Verhey FR, Koopmans RTCM, de Bie RA (2010). Prevalence, incidence and risk factors of paratonia in patients with dementia; a 1-year follow-up study.

In press;

Hobbelen J, Bettman I, Oosterhaven J, Looijen T, Outermans J. The geriatric patient with neurological problems. [Casus geriatrie neurologie] In; Clinical reasoning according to the HOACII [klinisch redeneren volgens de HOACII] . Wittink H, Engelbert R (Eds).