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RESEARCH ARTICLE

Why have people with dementia problems with walking and balance?

Jan van de Rakt^{1*}, Steve McCarthy-Grunwald²

¹Physical Therapist NDT teacher IBITA, Course Leader and teacher on the Dutch Institute for Allied Health Sciences. Nursing Home “Waelwick” in Ewijk, The Netherlands

²MSc BSc RMN Lecturer in Mental Health Nursing with Dementia Specialty. University of Cumbria, Bowerham Road, Lancaster, LA1 3JD England

*jan@vanderakt.nl

Abstract

Introduction: The walking performance and the balance are elements that change by people with dementia even before the diagnosis -dementia – is established. The reason is still a mystery, still there are investigations that think on an increase of pathological neurological increasing tone -paratonia. Investigations of that tone-increase are done in the beginning of this disease but mostly in a sitting-relax-position. But then is often a slight or even no increase present, but to know the impact, the tone measurement should be measure when people are performed this activity.

Method: To invest the impact of movements by people with dementia, we have taken the Rikli and Jones - Senior Fitness Test- by 35 participant with the diagnosis dementia. Further we did tests as the B.B.S., Tinetti, Statiek test and the tone measurement -Mas-P when walking or immediately after in stand or when stand was no option in sit.

Results: All participants give a worse results on the elements, balance, speed and walking and scored almost equal with age equal persons without dementia on the other items. The other tests (B.B.S., Tinetti, Statiek test) were also lesser and all had a higher tone when this measurement was done immediately after the walking/balance performance and certainly when they are doing the performance.

Conclusion: The impact of the pathological neurological tone (paratonia) was evident in this investigation of 35 people with dementia. The tone was the most important factor that interfered with the speed, walking and balance performance. But this asked for further investigation what walking and balance do with the tone of people with dementia. Further is it a question of an treatment as fall prevention on the way given now, has an effect or maybe has an negative influence on the balance performance. To get a better treatment than must the tone decrease, to get the possibilities of selectivity and speed possible and that is only possible in an gravity decreasing environment as par example water. That should be THE therapy that can slowdown the disease and stimulated the balance performance much longer than when the situation has to deal with gravity and thus an increase tone. Why have people with dementia problems with walking and balance?

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Introduction.

Complaints of people by the general practitioner that their walking and balance performance was altering and they couldn't find why. An group of general practitioners^[1] hold an record what was happen with this group, that complaints over the walking and balance performance and they find that this were the first symptoms of an possibility of an form of dementia. The second important finding was that the period was long about 8-10 years and that could be a sign that

dementia can be faster be found and with the possibilities to treat. Now in 2023 start the Uni of Rotterdam Erasmus University^[2] with an investigation to search for walking problems as an first sign, that there could be an neurological disease become manifest that is called dementia. There are an lot of forms of dementia and some differences are certainly there, but still now no investigation had makes this differences, therefore must we do with the determination that it could count for all forms of dementia.

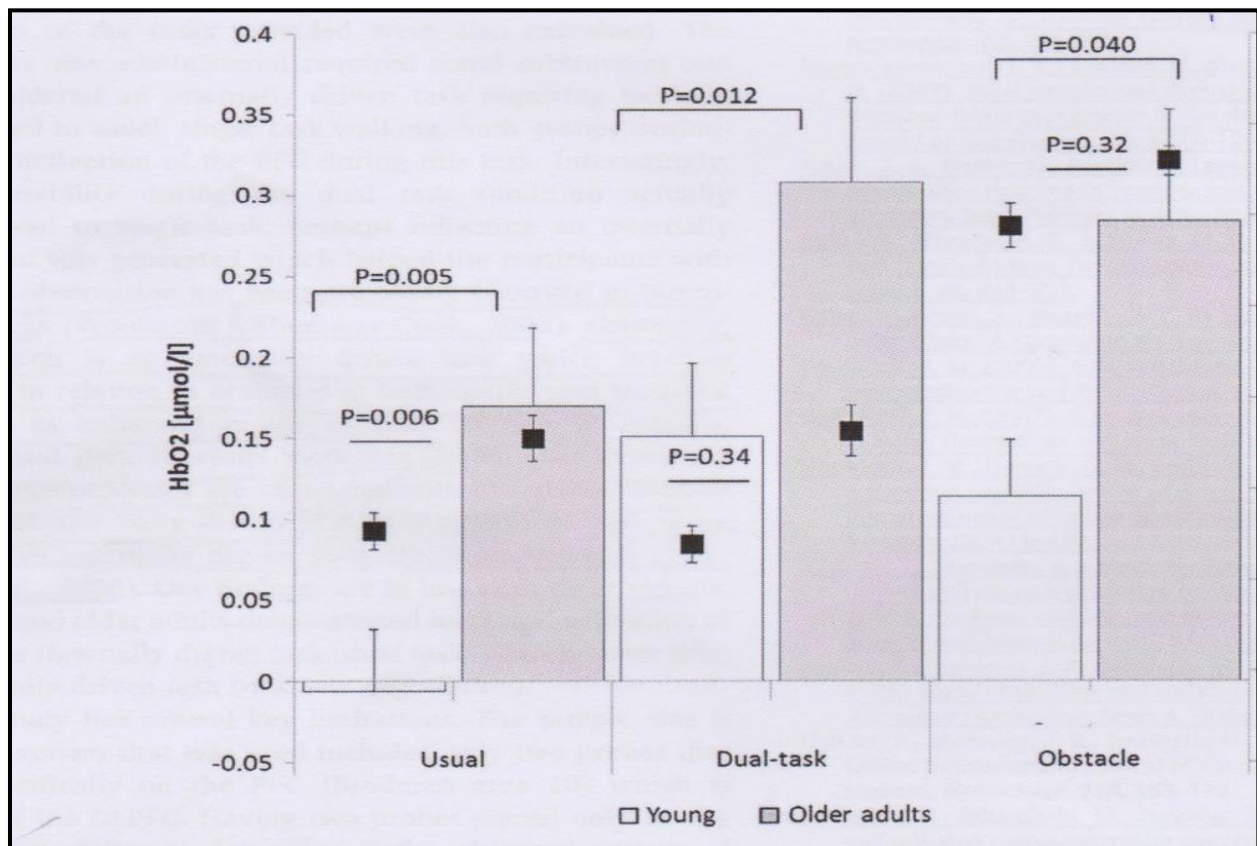


Figure 1. The differences between elderly and young people what is happen in the prefrontal area blood supply when they do three different assignments. Usual, double tasking and obstacle walking and then it is understandable that elderly are more carefully when it concern walking but this don't declared why elderly complaints about strange problems with their walking and balance and go to the general practitioner. But clear, elderly need more prefrontal area to get the job done.

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Get we search in the literature that we see that people has investigated people with MCI (Mild Cognitive Impairment) that there was an great loss on movement especially walking. Is this an sign that this complaints has also another behaviour?^[4,5,6]

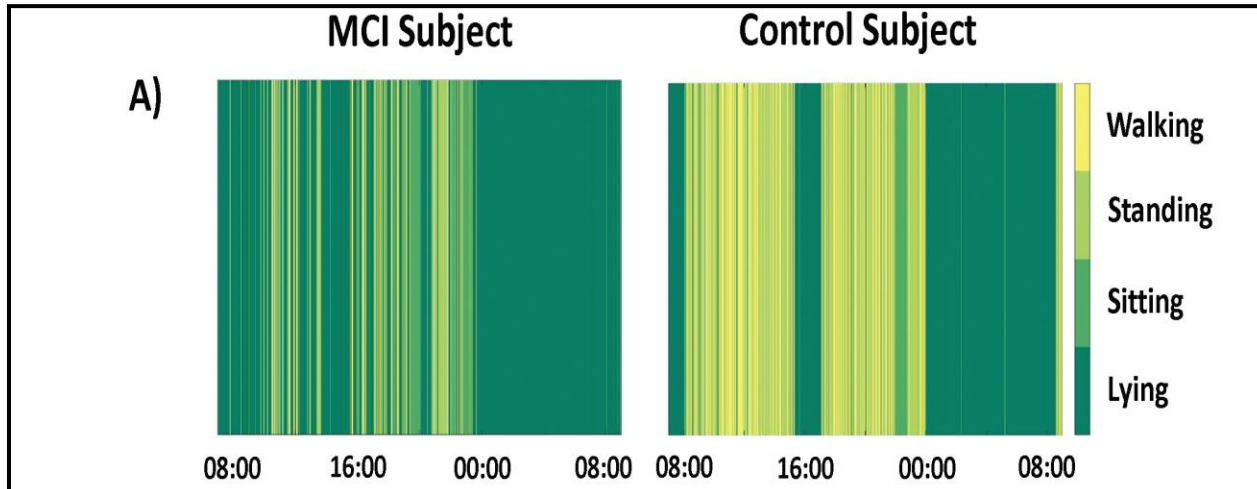


Figure 2. Let us see what amount of movement people make with the diagnosis MCI comparing with elderly with no such diagnosis. Than it is obvious that this people move lesser than others and again it is interesting why? As we figure 1 and 2 compare than it is obvious that elderly need more cognitive function to move comparing with young people but people with MCI has more problems. That elderly has more problems with all movement has an direct relation with the fact that elderly must adapt on the changes that occur when we get older but an group of elderly with neurological diseases has an extra problem.

An example of the adaptation of elderly that copy with the decreasing length and form of their attitude is known and looking at the change of this attitude makes it understandable that balance must also recovered to counter this changed attitude.

Figure 3 let see what the impact is when the spine is going in a kyphosis and therefore the midline is altering.

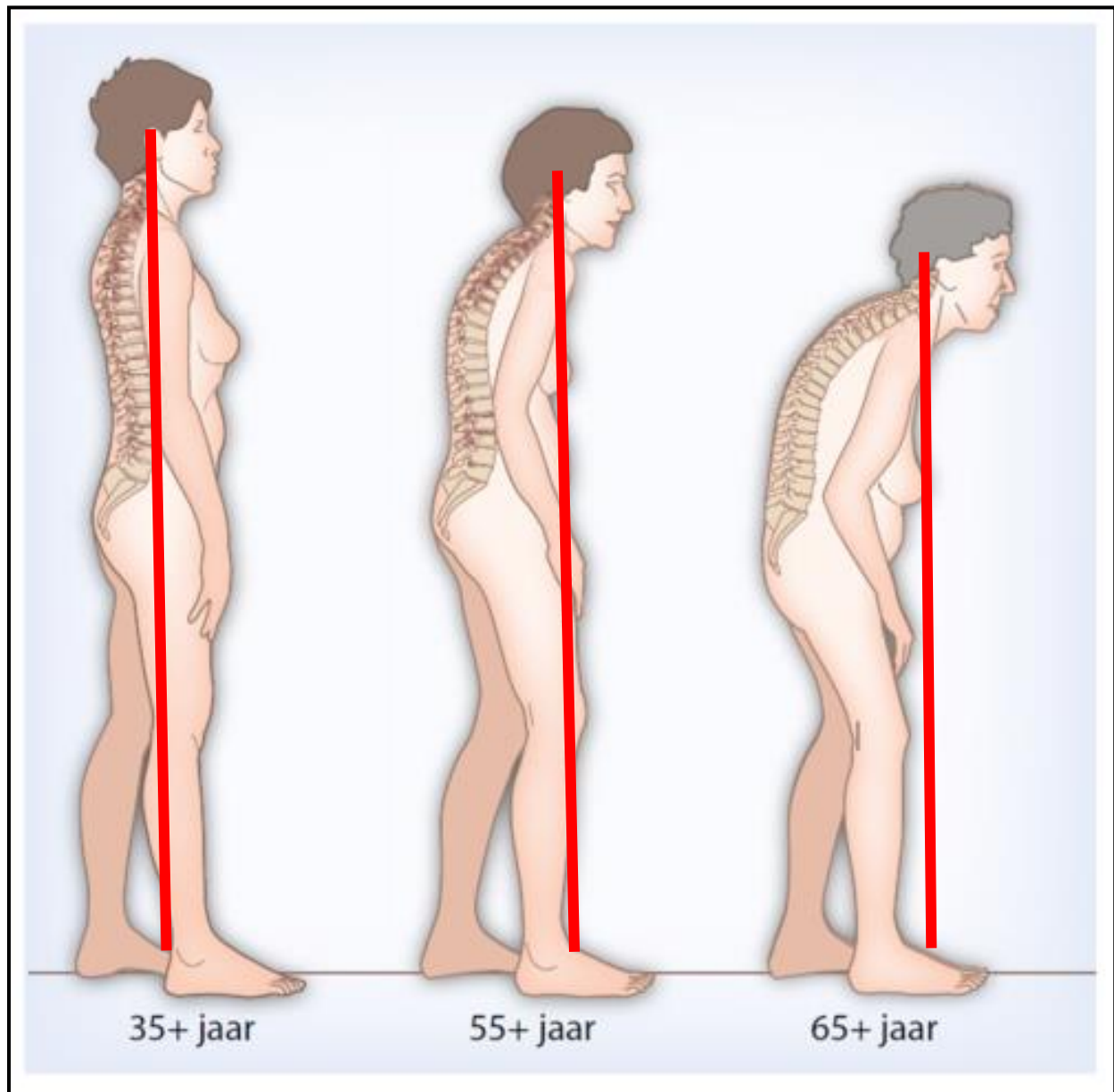


Figure 3^[7] This attitude changing asked for another muscles pattern to control the balance. Now the attitude is "out of balance "to the front because the upper body is too far to the front and that asked a continue activation of the back side all away till the calf muscles. This will give a reciprocal inhibition^[9] of the dorsal flexors and that will give less power of the dorsal flexors and therefore a lower counter action when balance is loosed to the back. Still many elderly will have count with this and hold the balance for a long time but will of course be need more cognitive elements to control it. A clear change will make the body perception as people often declare as she see how bend they walk when she see themselves in the mirror. This perception change is also an adaptation of the brain to create an optimal balance system to copy with this changing of the body.

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Knowing that the body is change is an sign of that adaptation, but what we see by people that loss their cognitive abilities is something different^[11] Here we see that their body perception is alter and isn't correctable

through them and they aren't aware of this change of body perception.

This is one of the first differences that people with dementia have as we them compare with elderly without dementia.

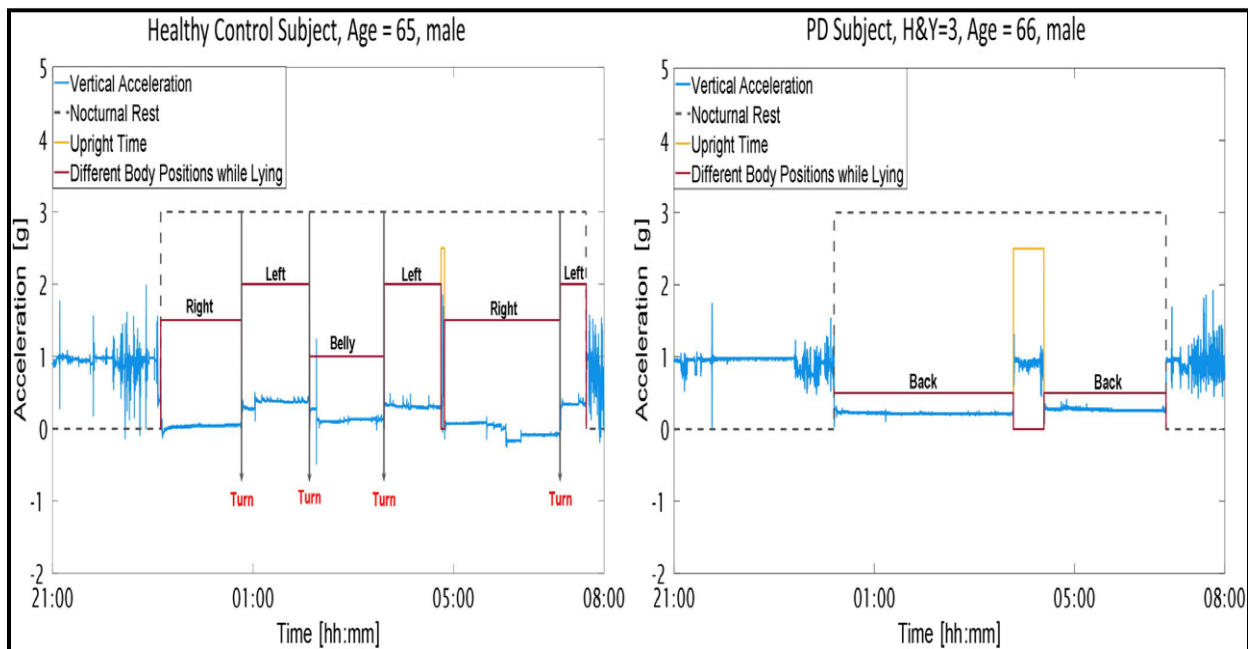


Figure 4^[8]. This investigation let us see which movements people with the Parkinson's disease make in bed during their sleep and what is clear that the amount of movements is lesser but also very poor. Clear that the Trunk Control Test (T.C.T.)^[12] isn't by the person on the right no 100 points. The reason that people with Parkinson's disease have so much problems with attitude changing in bed through the rigidity that increase during this disease. This makes dexterity, selectivity and thus small movements difficult and we see that this person can lie on his back and has only one alternative; sitting upright.

Thus that elderly with dementia has problems with their walking and balance must be have an direct relation with this neurological disease and it is very important to find this most common reason because than is treatment and slowing down of the effects of this disease on walking and balance possible.

material that could be help to find more out why the balance and walking was so difficult. Of course the amount of 35 participant is low. This group was walking with an aid, 33 with an rollator frame and two with an stick. This aid was given to them through the family and not through professionals.

What is changing in the beginning of this disease?

An research^[5] done with people that was coming to relieve their love-ones give us

The reason therefore was often that family say that the balance but especially the walking capacity wasn't optimal and therefore they search for an aid. To get it clear where this

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need lay, we started with an assessment^[13] and measurements as the Berg Balance Test (B.B.S.), Tinetti balance Test^[15], Statiek test^[16,17,18] to measure the balance level and search for the missing link but we start with the test that Rikli and Jones^[19] has developed around 2000 (Senior Fitness Test) for elderly to determinate what men and woman should performed on an certain age because we want to know or this people were capable to hold the level that belong by their age.

This 7 test were;

- 1. 30 second sit and stand test. In 30 seconds standup from an normal chair without using the hands.
- 2. Arm curl, the power of the elbow flexor.
- 3. 6 minute walk test, the distance that in 6 minute was done as fast as possible.

- 4. 2 minute step test, lifting one knee at the level of a stripe on the wall as fast as possible in 2 minute.
- 5. Chair sit-and -reach, mobility test to touch the toes.
- 6. Back Scratch, mobility test to reach on the back.
- 7. 8 foot up and go, or the Up and Go- test with standing up, walk and turn.

Now we could determinate or this persons with dementia perform according their age or that there were differences and where.

When she has the level that belong with their age, than this was called "normal". When she perform better thus better as the range that was given than this was "better". Below the border was called "border" and when it was firm below than was this called "worse".

Table 1

Person	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7
1 stick	border	normal	border	border	normal	normal	border
2 stick	border	normal	border	border	border	normal	border
3 R.F	worse	better	worse	worse	normal	border	worse
4 R.F	worse	normal	worse	worse	normal	border	worse
5 R.F	worse	border	worse	worse	normal	normal	worse
6 R.F	worse	normal	worse	worse	normal	normal	worse
7 R.F	worse	better	worse	worse	normal	normal	worse
8 R.F	worse	better	worse	worse	normal	normal	worse
9 R.F	border	normal	border	worse	normal	border	worse
10 R.F	worse	border	worse	worse	normal	border	worse
11 R.F	worse	normal	worse	worse	normal	border	worse
12 R.F	worse	border	worse	worse	border	border	worse
13 R.F	worse	normal	worse	worse	better	border	worse
14 R.F	worse	normal	worse	worse	normal	better	worse
15 R.F	worse	border	worse	worse	normal	normal	worse

Why have people with dementia problems with walking and balance?

Person	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7
16 R.F	worse	normal	worse	worse	normal	normal	worse
17 R.F	worse	border	worse	worse	normal	normal	worse
18 R.F	worse	normal	worse	worse	normal	normal	worse
19 R.F	worse	normal	worse	worse	normal	border	worse
20 R.F	worse	border	worse	worse	normal	border	worse
21 R.F	worse	border	worse	worse	normal	border	worse
22 R.F	worse	border	worse	worse	normal	border	worse
23 R.F	border	normal	border	worse	normal	border	border
24 R.F	worse	border	worse	worse	normal	border	worse
25 R.F	worse	border	worse	worse	border	border	worse
26 R.F	worse	better	worse	worse	border	worse	worse
27 R.F	worse	better	worse	worse	border	normal	worse
28 R.F	worse	border	worse	worse	border	normal	worse
29 R.F	worse	normal	worse	worse	border	normal	worse
30 R.F	worse	normal	worse	worse	border	normal	worse
31 R.F	border	border	border	border	border	normal	border
32 R.F	worse	border	worse	worse	border	normal	worse
33 R.F	worse	normal	worse	worse	border	better	worse
34 R.F	worse	border	worse	worse	better	border	worse
35 R.F	worse	normal	worse	worse	better	border	worse

Persons 3 till 35 walk with a rollator frame (R.F.)

Conclusion of this investigation by 35 people with the diagnosis dementia. (Regrettable was their no further diagnostic specification of what kind of dementia they suffer.) All participants had troubles with the items as speed, selectivity and dexterity and the items that asked for mobility or a sitting performance and move (the arm curl) than was their performance almost equal with people of the same age. But walking and especially fast walking, stand on one leg and lift the other, standing up and the Up and Go-test and then especially doing this fast was the greatest problem.

The balance test (B.B.S. or Tinetti) were also not optimal but almost all could perform on the border or little worse from the point that fall danger was present. But again was observe that the problem was speed and especially dexterity and selectivity. Thus the reason that they had a walking/balance aid was present but what was the greatest functional disorder that could explain this outcome.

The next test was de Statiek- test^[16,17,18], an test that invest the possibilities that someone have when he must react on little pressure on hip and/or shoulder height to the back, to the

front and sideways. This pressure asked for an immediately response that is equal with the pressure and that the whole body participate. Thus we feel the action but also see what the feet and trunk do, to prevent a fall movement.

All the participant has difficulties to react on this Statiek test as people should react of their age. The difficulties were; to react so fast and enough power as necessary to resist that little pressure. Often had participants problems to get the reaction on a continue level and must they every time again build up an equal pressure. Increasing the pressure gave the same problems, they were unable to react on the right level.

The conclusion of the Statiek test was therefore that there control over the body weight shifting wasn't optimal and that pointed for an changing body perception^[21,22] and/or not the selectivity in the muscles pattern that take care for this control of body weight shifting and that means that the brace when they came on the edge of their balance wasn't optimal and therefore had often too little time to make an good step strategy to restore balance.

The difference with this group people with dementia and the same group of that age without dementia was not that some muscle were low in power but that there was no possibility to adapt on this pressure situation and that pointed for an lack of selectivity. That means that we must search for a pathological neurological tone because than are the use of pathological synergy present and that would explain this lack on adaptation.

Remarkable detail by almost all participants when they walk without an walking aid under supervision where;

1. Walking not in the mid of the corridor but often at the side near the railing, some with slight touch and the people that walk in the mid where afraid walking through the square at the end of the corridor or, as love ones told, walking outside without an aid or contact with someone.
2. The rigidity of the head and upper trunk movements and the lack of expression on the face and "no interest" in the environment, only when the stood still. That give an attitude where the elbow were bended as a sign of some high tension.



Photo 1. This gentleman is walking through the corridor and he walks always in the mid, but he looks only straight forward and never sideways than he must stand still. Walking in the garden is often a great problem when there is no high hedge /fence on one side. Then he need support of someone. His balance test where B.B.S. 40 and the Tinetti 12, what let see that the danger for fall incidents is present. His possibilities to stand up out an chair is clear dependent of the height and form of that chair, but his possibilities to move in bed and come out bed isn't optimal. Often he need assistance and his T.C.T. is at his highest score 74 over 100. Often has he greater difficulties and need he much more assistance. The nurses feel on that occasion that he "don't cooperate" and he is very rigid.

Photo 1. The tone investigation gave clear tone increase of Mas-P^[23] in the knee extension and shoulder and elbow that was invest after an walking sessions through the garden in sitting position. When the tone was measure when this person lie on bed that was the Mas-P 0, only in some mornings this was higher on some occasions.

Tone investigation.

The last part of the assessment is the investigation of the tone. The literature gives clear signs that in the beginning of the disease there is often a tone increase. This tone is invest and called paratonia^[25]. The thesis of Dr. H. Hobbelen has given us an picture what this neurological pathological hypertonus differs from other hypertonus by other neurological disorders.

The occurrence of that paratonia is invest through the group around H. Hobbelen and

others have also see that people in the beginning of the disease has often a tone that is higher than normal. The tone is tested with a test called the MAS-P and is invest by others to get it of a good value. This give us an instrument that is equal with the tone measurements for person after an stroke^[30,31]

The tone measurement by the people in table 1 give the following results;

- The tone of the elbow and knee and then especially of the elbow flexors and the knee extensors was higher as also, but, lesser the

antagonist. This higher tone in the agonist as in the antagonist is one of the remarkable differences of paratonia comparing with spasm^[24], but often was the speed that is needed by this assessment so low that there isn't resistance to feel and that this only occur when the speed get higher as invest through Tardieu^[31] and college's.

Of the 35 persons this was the case by almost 20 persons but the differences where great. There were also differences by some persons that has no tone increase but the next day was there a resistance in the same movement and by the same speed.

This results where obtain when the person was in a sitting position and never directly after a walking performance and therefore was the hypothesis that the tone has decrease because the difficulty and gravity was changed.

- Therefore we started to do the test directly after the walking performance and when it was allowed when they stand still, but often was this difficult and was it almost impossible to feel or this was paratonia or higher tone to control the attitude.

But directly after an walking performance gave an better picture, now was the tone by all persons higher, certainly when we increase the movement-speed^[31] than was there always an resistance.

- Conclusion of this test was that direct after a walking performance, the tone was higher as normal and when this person sit longer than was the decrease clear greater. Thus the walking/balance performance and the gravity

asked from the damaged brain an higher pathological tone to control all freedom degrees^[32] and asked therefore an lot of all brain functions.

This other picture of the problems that people with dementia have with movements and especially walking and balance what asked for selectivity, dexterity and speed directly after the performance compared with the investigations that are done in sitting-relax position. The arm curl was such an example where there were no clear differences that where there on all walking or balance performances. Thus must the tone measurement also occur when they move? This was difficult and as a solution we measure directly after but maybe with the Myotron-pro^[26] device, we get the opportunity to measure when people performed.

Important!!

To know what is happen with the tone when people with dementia move is essential when we want to treat this people. Treatment of people with dementia is still, now, only possible through movement that increase the blood circulation of the brain and slower down this disease^[33,34,35,36]. Aerobic treatment with a good amount of intensity will increase the blood circulation and has effects on several brain elements as the hippocampus and also anaerobe treatment has an good effect but we must be careful or this can have an effect on the balance performance.

Walking as training.

Thus that means that walking performance can be trained by people with dementia but there is a border. The border is the paratonia that will increase when people increase their speed and/or when they walk longer and the fatigue increase.

Than is the amount of effort that is necessary must larger than people with no increase of an pathological tone and the danger that the balance is decrease is increasing.

The problem to get the right level of intensity^[36] to get an positive reaction in the brain is than difficult or maybe impossible to achieve.

Balance performances.

The limit for balance training is through the increasing of the pathological neurological tone also difficult, because to train this, the person must train in an position that need an balance reaction and asked for the speed to react with an body reaction that give time to make an foot free, to make an step-strategy and that will be slowing down through the paratonia. That means that all fall prevention programs will have less positive effects and will this person give no benefit, but the therapists that do this fall-prevention program are often the first that see what the reaction is and could be through tone measurement search for an clear sign that can be helpful for an fast diagnosis and thus an early treatment.

The signal that people cannot participate because the increase of the paratonia make it impossible, should be important sign that people with dementia has through that

problems with all kinds of movements and then must we search and invest other treatment forms.

Other treatment form.

Knowing that the pathological tone is one of the reason that the functioning level is decreasing, was the reason to change of the therapy-intensity by people after an stroke, Parkinson and dementia^[38]. That intensity increase the tone and make movements for all participants more difficult. Decreasing the intensity/heaviness level, was it possible the negative effects of the this treatment in the period before to reduce and one of the pillars was hydrotherapy^[39,40,41].

Hydrotherapy.

Hydrotherapy is an form of therapy that is capable to change elements that occur in diseases with brain damage and make it possible to move on better level than on land.^[42,43,44,45,46.]

The sensorics input will be increase and the tone will be decrease and this two elements will give the damage brain the possibility to do more with the residual power. Furthermore will the water stimulate the aerobe and the anaerobe activity?

That means that the blood circulation in the brain will be increase but also the balance training can be done on an task specific^[47] way with the possibility to give resistance and the balance reaction can be done in the water because the fall will be through the water be safe. The transfer of the training in water on land is positive^[48] but still, will there be an increase of tone by people with dementia

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through the gravity. But there are an lot of clues that training in the water on an regular base give positive effects on the slowing

down process of the disease as on the possibilities to move walk and control the balance.



Photo 2. An example of a treatment in water, in this case with floating aids a walking training to stimulate the base movements of the trunk when people are walking ^[51].

The positive elements of the water is that group therapy is possible and still must every participant search for the individual optimal situation to copy with the influences of water.

Water will asked for continue counter movements also through the movements of others. That give an aerobe stimulus certainly when the water gives resistance when the speed of walking is increase, but also the balance can be easy be stimulated all away to and over the edge of the balance reaction with no fear for damage.

This element is only possible in water and will therefore stimulated the brain to search for solution without the use of tone increasement.

Conclusion.

The possible reason that the walking and balance performance by people with dementia is often so fast negative changing, even before the disease is diagnosed, is a source for investigation over an long period. Still there are clear signals that the pathological increase tone is an very important factor but the measurements of that tone increase is till now done in an relax, sitting position and it would be very important that this measurements are done when people are walking or doing balance movements. When this tone is the factor that

makes walking and balance difficult than must the therapy be so that this don't lead to a tone increase and till now is all the therapy that is given, including the fall-prevention, a tone increasing exercise.

Thus must the therapy be done in an environment that decrease the tone and also stimulate the aerobe and anaerobe activity to slow done the disease but have also an positive slowing down effect on the walking /balance performances. And that treatment must be give on a regular base and should be an issue for further investigation what the best treatment is for the disease dementia.

Corresponding Author:

Jan van de Rakt

Physical Therapist NDT teacher IBITA,
Course Leader and teacher on the Dutch
Institute for Allied Health Sciences.
Nursing Home "Waelwick" in Ewijk,
The Netherlands
Email: jan@vanderakt.nl

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References:

1. Ramakers I, Visser P, Aalten P, Boesten J, Metsemakers J, Jolles J, Verhey F. Symptoms of Preclinical Dementia in General Practice up to Five Years before Dementia Diagnosis. *Dementia and Geriatric Cognitive Disorders*. 2007.
2. Investigation starting in the University of Rotterdam Erasmus. 2023. Gelderlander
3. Mirelman A, Maidan I, Bernad-Elazari H, Shustack S, Giladi N, Hausdorff JM. Effects of aging on prefrontal brain activation during challenging walking conditions. *Brain Cogn*. 2017 Jul;115:41-46. doi: 10.1016/j.bandc.2017.04.002. Epub 2017 Apr 21. PMID: 28433922.
4. Hausdorff J, Hillel I, Shustak S, Del Din S, Bekkers E, Pelosin E, Nieuwhof F, Rochester L, Mirelman A. (2017) Everyday stepping quantity and quality among older adult fallers with and without mild cognitive impairment: Initial evidence for non-motor markers of cognitive deficits? *The journal of Gerontology*. 08 October Doi: <https://doi.org/10.1093/geron/glx187>.
5. Van de Rakt J, McCarthy-Grunwald S. Physical treatment of individuals with dementia. Part 1 A. *Ita. J. Sports Reh. Po.*; 2020 ; 7 ; 2 ; 1546 -1581 ISSN 2385-1988 [online] IBSN 007-111-19 - 55 CGI J OAJI :0,101
6. Scherder E. (2017) *Singing in the brain*. Athenaeum –Polak\$ Van Gennep .ISBN.978025307035
7. Zhang Y, Zhou X, Pijnappels M, Bruijn S. Differences in gait stability, trunk and foot accelerations between healthy young and older women bioRxiv 25. 2021.
8. Mirelman A, Hillel I, Rochester L, Del Din S, Bloem B, Avanzino L, Nieuwboer A, Maidan I, Herman T, Thaler A, Gurevich T, Kestenbaum M, Orr-Urtreger A, Brys M, Cederbaum J, Giladi N, Hausdorff J. Tossing and Turning in Bed: Nocturnal Movements in Parkinson's Disease. *Movement Disorders* 2020.
9. Itoer MK, Danielian LE, Kim YK. Effects of motor skill learning on reciprocal inhibition. *Restor Neurol Neurosci*. 2013;31(1):53-62. doi: 10.3233/RNN-120247. PMID: 23142814; PMCID: PMC4279717.
10. Fallah-Tafti F, Watson K, Blaskewicz Boron J, Myers S, Schmid K, Yentes J. Strength of plantar- dorsiflexors mediates step regularity during a high cognitive load situation in a cross-sectional cohort of older and younger adults. *Journal of Geriatric physical therapy*. 2019.
11. Kraft P, Gadeholt O, Wieser M (2009) Lying obliquely—a clinical sign of cognitive impairment: cross sectional observational study *BMJ*. 16: 339-b5273.
12. Franchignoni D (1997) Trunk Control Test as an early predictor of stroke rehabilitation outcome. *Stroke* 28:1382- 1385.
13. Van de Rakt J, Grunwald SMC (2020) *Dementia, How We Can Create the Best Quality of Life for Them*. OSP J Health Car Med 1. HCM-1-113

14. Berg WP, Alessio HM, Mills EM, et al. (1997) Circumstances and consequences of falls in independent community dwelling older adults. *Age Ageing* 26: 261-268.
15. Curcio F, Basile C, Liguori I, Della-Morte D, Gargiulo G, Galizia G, Testa G, Langellotto A, Cacciatore F, Bonaduce D, Abete P. Tinetti mobility test is related to muscle mass and strength in non-institutionalized elderly people. *Age (Dordr)*. 2016 Dec;38(5-6):525-533. doi: 10.1007/s11357-016-9935-9. Epub 2016 Aug 26. PMID: 27566307; PMCID: PMC5266213.
16. Van de Rakt J. (2018) Statiek. Nieuwsbrief . NHV
17. Muskens M. Waarnemend behandelen vanuit een sensomotorisch perspectief De visie van Gerard Worm op het menselijk bewegen. 2022. Uitgevers 2010. ISBN 9789490951719
18. Worm G (2011) Cursus waarnemen en behandelen. Papendal.
19. Rikli R, Jones C (2002) Senior Fitness Test. *Active aging* 1-30.
20. Kang L (2017) Timed up and Go test can predict recurrent falls; a longitudinal study of the community-dwelling elderly in China. *Clin Interv Aging*. 12: 2009-2016.
21. Robinovitch S, Feldman F, Yang Y, et al. (2012) Video capture of the circumstances of falls elderly people residing in long-term care: an observational study. *Lancet*.
22. Van Schooten K (2014) Predicting falls. Amount and quality of daily-life gait as risk factors. Thesis 30-78
23. Waardenburg H. en anderen (1999) Is paratonie betrouwbaar te meten? *Ned.Tijdsch.v.Fysio*. nummer 2.
24. Hobbelen JS (2010) Paratonia enlightened. Definition, diagnosis, course, risk factors, and treatment. Proefschrift. Enschede, Gildeprintdrukkerijen.
25. Van Deun B. Van Den Noortgate N. Saucedo C. Van Bladel A. Cambier D. A Paratonia in Flemish nursing homes: Current state of practice. m *J Alzheimers Dis Other Demen*. 2018
26. Van Deun B. Hobbelen H. Cagnie B. Van Eetvelde B. Van Den Noortgate N. Cambier D. Reproducible measurements of muscle characteristics using the MyotonPRO device: Comparison between individuals with and without paratonia *J Geriatr Phys Ther*. 2018
27. Van Deun B. Van Den Noortgate N. Van Bladel A. Palmans T. Cambier D. The impact of paratonia on fine and gross motor function in older adults with mild and moderate dementia. *Alzheimer Dis Assoc Disord*. 2018 Oct 26.
28. Van Deun B. Van Den Noortgate N. Van Bladel A. De Weerd K. Cambier D. Managing paratonia in persons with dementia: Short-term effects of supporting cushions and harmonic techniques. Submitted for publication to *Journal of the American Medical Directors Association* 2018.
29. Drenth H. Zuidema S. Bautmans I. Marinellie L. Kleiner G. and Hobbelen H. Paratonia in Dementia: A Systematic Review. *Journal of Alzheimer's Disease* 2020.

30. Bohannon R.W., Smith M.B (1987) Interrater reliability of a modified Ashworth scale of muscle spasticity. *Phys.Ther* 67: 206-207
31. Tardieu G., Rondont O., Mensch J., Dalloz J., Monfraix C., et al. (1997) Responses electromyographiques à l'étirement musculaire chez l'homme normal. *Revue Neurologie* 60-61.
32. Bernstein L. The coordination and regulation of movements Pergamon Press New York 1967.
33. Erickson KI, Voss MW, Prakash RS, Basak C, Szabo A, Chaddock L, Kim JS, Heo S, Alves H, White SM, Wojcicki TR, Mailey E, Vieira VJ, Martin SA, Pence BD, Woods JA, McAuley E, Kramer AF. Exercise training increases size of hippocampus and improves memory. *Proc Natl Acad Sci U S A*. 2011 Feb 15;108(7):3017-22. doi: 10.1073/pnas.1015950108. Epub 2011 Jan 31. PMID: 21282661; PMCID: PMC3041121.
34. Groot C, Hooghiemstra AM, Raijmakers PG, van Berckel BN, Scheltens P, Scherder EJ, van der Flier WM, Ossenkoppele R. The effect of physical activity on cognitive function in patients with dementia: A meta-analysis of randomized control trials. *Ageing Res Rev*. 2016 Jan;25:13-23. doi: 10.1016/j.arr.2015.11.005. Epub 2015 Nov 28. PMID: 26607411.
35. Bossers WJ, van der Woude LH, Boersma F, Hortobágyi T, Scherder EJ, van Heuvelen MJ. A 9-Week Aerobic and Strength Training Program Improves Cognitive and Motor Function in Patients with Dementia: A Randomized, Controlled Trial. *Am J Geriatr Psychiatry*. 2015 Nov;23(11):1106-16. doi: 10.1016/j.jagp.2014.12.191. Epub 2015 Jan 3. PMID: 25648055.
36. Norton K, Norton L, Sadgrove D. Position statement on physical activity and exercise intensity terminology. *J Sci Med Sport*.2010;13(5):496–502.
37. Van de Rakt J (2013) Balanstraining bij ouderen. *Physios* 3: 12-24.
38. van de Rakt J and McCarthy-Grunwald S, 2022. Tone- Increase is an Answer after a Brain Damage: But How High Is Good?, *Medical Research Archives*, [online] 10(10). <https://doi.org/10.18103/mra.v10i10.313>
39. Van de Rakt J, Mc Carthy Grunwald S (2022) Physical treatment (Hydrotherapy) by individuals with and without dementia. *Aquatic exercising. Part 1 Ita J Sports Reh Po* 3: 1989-2017
40. Van de Rakt J, Lambeck J (2004) Therapeutisch zwemmen met" verpleeghuis" patiënten? N.V.F.G.
41. Lambeck J.(2001) Hydrotherapie . Uigave N.P.I. ISBN; 9076986096.
42. Hamed S and others. The effects of Halliwick aquatic exercises on gross motor function of children aged from 3 to 5 years with spastic cerebral palsy. *Pedagogy of Physical culture and Sports* 2023 doi:10.15561/26649837.2023.0103
43. Sato M, Miyake J, Hashimoto Y, (2010) Tactile Perception of a Water Surface: Contributions of Surface Tension and Skin Hair.

44. Tripp W. Effekte der bewegungstherapie im wasser auf die funktionelle mobilat bei schal anfall patienten, eine kontrollierte ,randomisierte studie. Thesis. Uni. Frankfurt am Main, 2011
45. Fedor A (2015) The Effects of A Brief, Water-Based Exercise Intervention on Cognitive Function in Older Adults. Arch Clin Neuropsychol 30: 139-47.
46. Camper U. Wasserspezifische bewegingstherapie und training ; Gustav Fisher verlag. 1995
47. Bosch F (2010) Krachttraining en coördinatie. Uitgevers 2010.
48. Henz D, Schollhorn W (2016) Differential training Facilitates Early consolidation in Motor learning. Front Behav Neurosci 10:199.
49. Voncken en anderen, BrabantZorg (2014) Pilot: Bewegen met water. Team Bewegingsagogie en Psychomotorische therapie. NHV nieuwsbrief 4.
50. Als een vis in het water, zwemmen met dementerenden. Diesfeldt H. Februari 2015 DENKbeeld
51. Van de Rakt J. The diagonal-muscles pattern of the trunk.: Basic of all Movements. Scholars press.2021. ISBN 978-613-8-96056-0