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Original Study

Managing Paratonia in Persons With Dementia: Short-term Effects of Supporting Cushions and Harmonic Techniques

Bieke Van Deun PhD [a,*], Nele Van Den Noortgate PhD [b], Anke Van Bladel PhD [a], Koen De Weerdt MsC [a], Dirk Cambier PhD [a]

[a] *Department of Rehabilitation Sciences and Physiotherapy, Ghent University, Ghent, Belgium*
[b] *Department of Geriatrics, Ghent University Hospital, Ghent, Belgium*

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A B S T R A C T

Objectives: Paratonia, a form of hypertonia typically seen in dementia, is often associated with difficulties in positioning and daily care. No evidence-based therapy or clinical guideline for management is available. In this study, the short-term effect of harmonic techniques (HT) and supporting cushions (SC) on paratonia was explored.
Design: This was a multicenter interventional clinical trial with AB/BA crossover design. Each intervention (SC or HT) was subsequently implemented over 1 week in each of the participants.
Setting and participants: The study included 22 participants with moderate to severe paratonia from 9 different nursing homes in Flanders, Belgium.
Methods: Measurements of biceps brachii and rectus femoris muscle tone (MyotonPRO), maximal elbow and knee extension (goniometer), and pain (Pain Assessment Checklist for Seniors With Limited Ability to Communicate) were performed on 3 different days within 1 week. The effect of HT on nursing care was evaluated with the Pain Assessment Checklist for Seniors With Limited Ability to Communicate and visual analog scale ratings of discomfort items.
Results: After 30 minutes of positioning with SC, participants had lower biceps brachii muscle tone ($P = .041$) and higher maximal elbow extension ($P = .006$) than without SC. After a 30-minute session of HT, a significant increase in biceps brachii muscle tone ($P = .032$) and maximal extension of elbow ($P < .001$) and knee ($P = .028$) was found. Pain ($P = .003$) and discomfort ($P = .001$ to $P = .019$) during morning care were significantly lower when care was preceded by 30 minutes of HT.
Conclusions/Implications: This explorative study revealed beneficial short-term effects on range of motion for both SC and HT and a positive effect of SC on upper limb muscle tone. Beneficial effects of HT were found on resident's pain and caregiver's discomfort during care. The results of the present study are encouraging and can contribute to the development of evidence-based interventions for paratonia.

Dementia is associated with a wide range of motor disturbances, which are often under-recognized.[1–7] Paratonia, a type of hypertonia characterized by a variable and involuntary resistance to passive movement, is present in 10% of early-stage and 90%-100% of end-stage dementia.[1,2,8–11] It affects patients' quality of life, because it is associated with pain, contractures, and decubitus, and causes caregivers' strain through difficulties in positioning and daily care, particularly in end-stage dementia.[12] Notwithstanding the high clinical relevance, the body of knowledge concerning paratonia is scarce and evidence-based therapy is lacking. Some studies have proposed passive mobilization, which might induce a transient positive effect immediately after therapy, but no long-term beneficial effect on paratonia has been established.[13] On the contrary, stretch on activated, hypertonic muscles might cause microtrauma in already fragile muscle tissue, causing pain and a further increase of muscle tone.[13,14] Therefore, passive mobilization cannot be recommended as an effective and safe intervention for paratonia.[13] In some cases of severe paratonia, local botulinum toxin administration could be considered in order to allow proper nursing and care by increasing range of motion.[15] Yet this is a local intervention, and paratonia is usually present in large parts of the body; therefore other "globalized" interventions are needed.

The authors declare no conflicts of interest.

* Address correspondence to Bieke Van Deun, PhD, Department of Rehabilitation Sciences and Physiotherapy, Campus UZ Gent, 1B3, entrance 46, Corneel Heymanslaan 10, B-9000 Ghent, Belgium.

E-mail address: bieke.vandeun@ugent.be (B. Van Deun).

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By lack of evidence-based guidelines, physiotherapists and other caregivers are trying to deal with the consequences of paratonia with a variety of therapeutic strategies based on empirical findings and hypothetical theories. In a recent survey, physiotherapists in nursing homes in Flanders (Belgium) mentioned positioning and soft passive mobilization as the most frequently used strategies.[16]

Positioning can be achieved by means of a diverse range of positioning methods and/or aids and all have the common purpose to provide stability, comfort, and relaxation.[16] By providing additional support to contractured limbs, a decrease of discomfort and risk of decubitus can be pursued. It is also hypothesized that persons with paratonia might compensate for a decreased body perception by searching for tactile information (eg, by pressing their knees together, rendering a forced position).[17] Offering tactile input (by using cushions) could possibly diminish the need for other input and have a beneficial effect on paratonia. Scientifically, the effect of supporting cushions (SCs) on paratonia has only been described in a case report and small pilot study, and results are inconclusive.[17,18]

Another frequently applied intervention, according to the results of the Flemish survey, was passive mobilization.[16] However, passive mobilization as such cannot be recommended because of possible adverse effects.[13] The use of pulsating/oscillating movements was suggested as an alternative to passive mobilization, because relaxation obtained by rocking movements may induce muscle tone reduction.[16,19] Such soft pulsating movements are described by Lederman as harmonic techniques (HT), which contain a group of manual techniques bringing a state of resonance in body masses and tissues by gentle rocking of (parts of) the body.[20] Though mainly based on empirical findings, HT claim to have an effect on local tissue organization (eg, mechanical changes), neurologic organization (eg, increased proprioception and pain gaiting), and psychophysiological organization (eg, generalized motor tone reduction, autonomic changes, modification of pain perception and tolerance, body-image integration, and relaxation).[20] Studies on rhythmic spinal manual mobilization reported local and systemic pain reduction, and after cervical oscillatory mobilization, alterations in muscle activity were described.[21–25] We are not aware of any study regarding the application of HT on paratonia.

Given the importance of the epidemiologic and clinical challenge of dementia, there is a strong need to study the effects of treatments strategies on paratonia. The purpose of this explorative study was to examine the short-term effect of both SC and HT on muscle tone, range of motion, pain, and daily care in persons with moderate to severe paratonia.

Methods

Design and Sample

This was a multicenter interventional clinical trial with AB/BA crossover design. The research protocol was approved by the ethics committee of the Ghent University (EC/2016/0019), and a written consent was obtained by the legal representative of all participants. Participants from 9 Flemish nursing homes were included in this study. Inclusion criteria were a diagnosis of dementia (confirmed by the medical file) and the presence of moderate to severe paratonia (evaluated with the Paratonia Assessment Instrument[26] and Modified Ashworth Scale for paratonia[27]).

Experimental Procedure

The study consisted of 2 interventions. Each intervention (SC or HT) was subsequently implemented over 1 week in each of the participants. Measurements of research variables took place on 3 different days spread over the week.

SC part

Measurements took place in the afternoon, after participants—who spent the morning and lunchtime in a (wheel)chair—were transferred to their beds. On each measurement day, there were multiple measurements: (M1) immediately after the transfer and positioning without using SC; (M2) after 30 minutes in bed, still without SC; (M3) immediately after positioning with SC; and (M4) after 30 minutes positioning with SC. Between M2 and M3, supporting cushions were placed. On the remaining days, there were no positioning prescriptions.

HT part

During 1 week, the usual morning care was preceded daily by 30 minutes of HT, and measurements took place on 3 different days spread within that week. In order to respect as much as possible the usual time schedules of daily care, all interventions and measurements took place in the morning. On each measurement day, there were multiple measurements: (M1) baseline measurement before HT; (M2) immediately after HT; and (M3) after daily morning care. Additionally, nurses (or nursing auxiliaries) evaluated pain and discomfort during morning care by means of PACSLAC-D and visual analog scale (VAS) ratings of discomfort over 2 weeks: (1) control week without HT (=week preceding HT week) and (2) HT week.

Interventions

SC

Cushions were placed in a way that a participant's head and limbs were well supported, without leaving empty spaces between body and cushions or mattress. Abundant cushions were used, in order to stabilize the body and to provide a surrounding of tactile information. Eventual rotation of the legs (and spine) to one side was neutralized by additional support at that side, and if possible a cushion was placed between the legs. Special attention was paid to the facial expression of the participant to judge if the positioning was comfortable. The exact positioning was thus subject to certain degrees of interpersonal and interdiurnal differences; however, the principles were respected and therefore intended comfort could be assessed equal. Any type of cushions could be used for this purpose. An example of positioning can be seen in Figure 1.

HT

HT were applied to the upper limbs (ULs), lower limbs (LLs), and trunk. To maximize the harmonic oscillating effect of the HT, balloons were placed under the limbs of the participant in order to provide additional movement resonance (Figure 2). Sessions of 30 minutes were performed by local physiotherapists with a foregoing training in HT. The sequence and timing of targeting either part (UL, LL, trunk) were not predetermined and could be decided according to the actual needs of the participant.

Measurements

Outcome variables were measured in a fixed order: (1) MyotonPRO measurement of left and right biceps brachii, and left and right rectus femoris; (2) measurement of left elbow extension, right elbow extension, left knee extension, right knee extension; and (3) PACSLAC-D. A researcher of the Ghent University performed these measurements.

Fig. 1. Example of positioning with supporting cushions.

MyotonPRO measurement

The MyotonPRO (Myoton AS, Tallinn, Estonia) is a noninvasive, portable device for determining intrinsic muscle tone based on frequency of oscillations elicited by a mechanical stimulus on the skin above the muscle belly. Moderate to high reliability and low but significant correlation with MAS-P have been reported in persons with paratonia.[28,29] In this study, we used the multiscan mode (10 taps), and the mean of 2 consecutive series of 10 taps was used for analysis.[28] For both biceps brachii and rectus femoris muscles, the measurement point was located at one-third of the total muscle length, starting distally. All measurements took place in a supine position, yet no standardized limb position was used in order to avoid influence on muscle tone by manipulating the limbs before measurements. Series were erased and repeated if the coefficient of variation of the 10 taps exceeded 3%.

Fig. 2. Example of application of harmonic techniques.

Range of motion

In supine position, a very slow gradual extension of elbow and knee was performed, up to the point where further motion was made impossible because of active resistance or caused a visible discomfort to the participant. This maximal extension was measured with a manual goniometer, with negative degrees expressing an extension deficit. High inter- and intrarater reliability have been reported in healthy adults, yet no reliability studies have been performed in persons with paratonia.[30]

PACSLAC-D

This is a valid and reliable Dutch adaptation of the Pain Assessment Checklist for Seniors with Limited Ability to Communicate (PACSLAC),[31] an observation scale for pain detection in older adults living with dementia.[32–34] Presence of 24 items (clustered in 3 categories: facial expression, resistance/defense and social/emotional/mood) is scored, with a score of ≥4/24 indicating pain.[33] PACSLAC-D was rated by (1) the researcher, after each measurement (HT and SC part); (2) the local physiotherapist, after performing the HT; and (3) nurses (or nursing auxiliaries), both during the control week without HT and during the HT week, daily after performing morning care.

VAS discomfort rating

Both during the control week without HT and during the HT week, nurses (or nursing auxiliaries) were asked to daily evaluate discomfort during the morning care session by indicating on a 10-cm VAS their responses to 4 questions:

(1) How high was the (physical) care load for you (physical inconveniences such as back pain, fatigue . . . caused by this care performance)? (0 cm = no physical load at all; 10 cm = very high physical load)
(2) To what extent do you estimate that morning care was uncomfortable/wearisome for the resident? (0 cm = not uncomfortable/wearisome at all; 10 cm = very uncomfortable/wearisome)
(3) To what extent was care performance hampered by reduced mobility (eg, armpit or personal hygiene zone difficult to reach)? (0 cm = not hampered at all; 10 cm = very much hampered)
(4) How would you rate the global smoothness of care performance? (0 cm = very laborious; 10 cm = very smooth)

Paratonia Assessment Instrument (PAI) and Modified Ashworth Scale (MAS)

In these clinical tools used for verification of inclusion criteria, the limbs are passively moved and the characteristics (PAI) and amount (MAS) of experienced resistance are evaluated.[26,27] Moderate to severe paratonia was defined as the presence of an MAS score of ≥2/4 in at least 1 limb.[13]

Statistical Analysis

Analyses were performed using SPSS version 25. Data were checked for normality using the Shapiro-Wilks test. Linear mixed models analysis was used with “day,” “measurement,” “UL/LL,” “nursinghome,” “UL/LL*measurement,” and “day*UL/LL*measurement” as fixed factors and “left/right” as covariate. For pairwise comparison, a

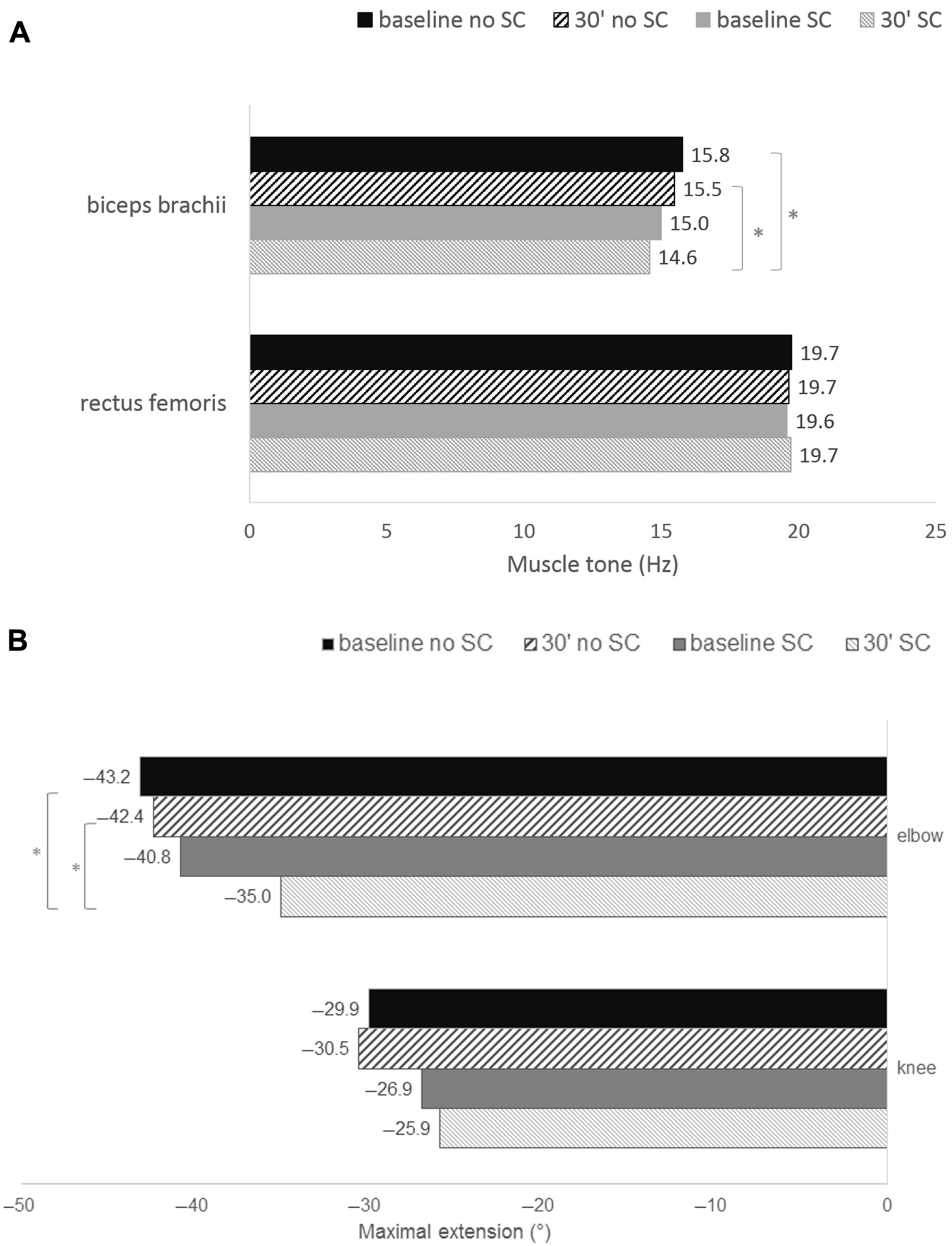

Fig. 3. The influence of SC on (A) MyotonPRO measurements of biceps brachii and rectus femoris muscle tone (Hz) and (B) maximal elbow and knee extension (°).*Significant at .05.

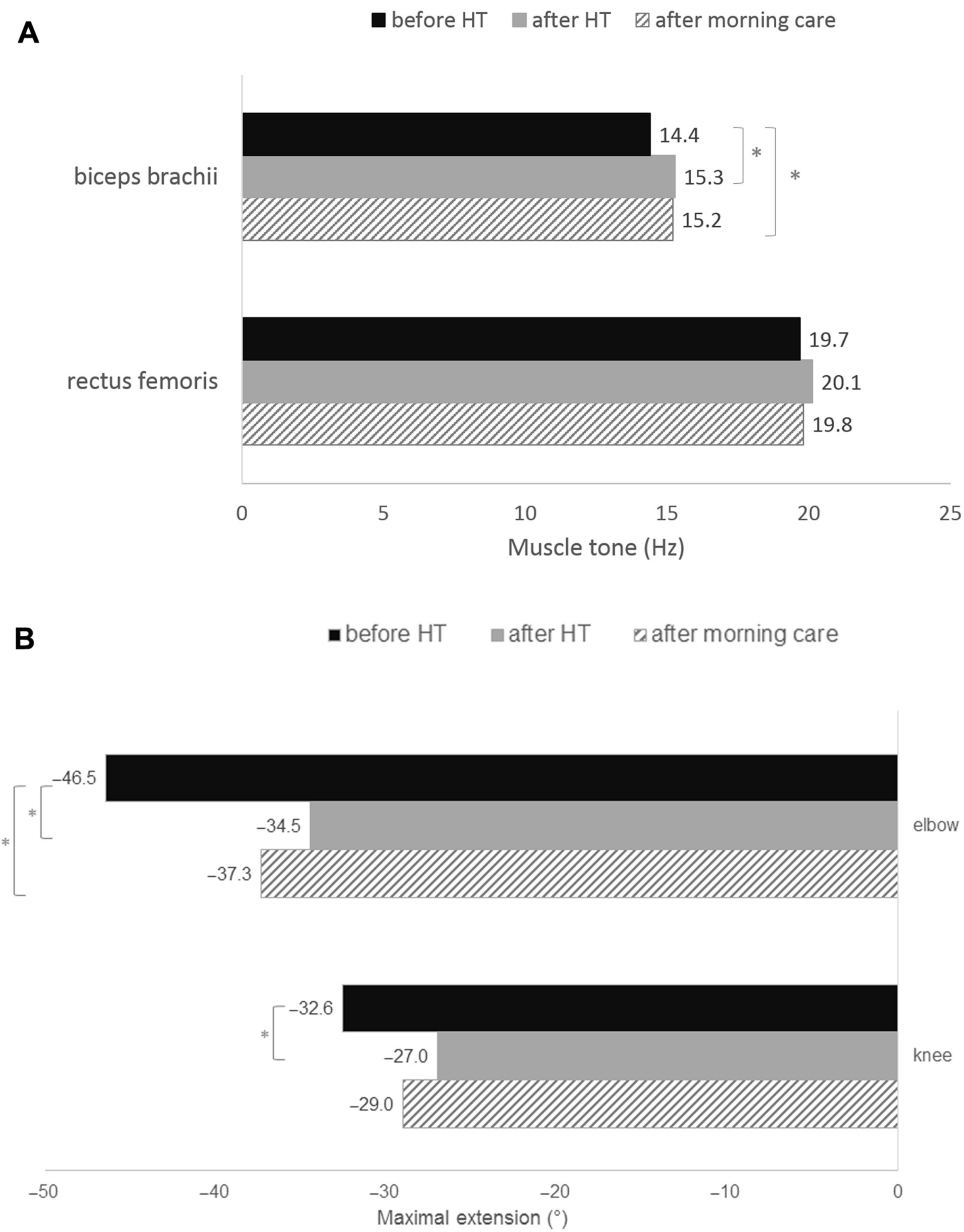

Fig. 4. The influence of HT on (A) MyotonPRO measurements of biceps brachii and rectus femoris muscle tone (Hz) and (B) maximal elbow and knee extension (°). *Significant at .05.

Bonferroni correction was used. Level of significance was set at 0.01 for normality tests and 0.05 for other tests.

Results

Participants

Twenty-two participants living in 9 nursing homes (2-4 participants per nursing home) were included in the study. All participants had severe cognitive decline (Global Deterioration Scale score of 6 or 7).[35] Ten participants were diagnosed with Alzheimer's dementia, 1 had vascular dementia, 1 had frontotemporal dementia, and in 10 participants the type of dementia was not determined. Age ranged from 67 to 96 years, with a mean of 84.8 ± 7.3 years.

Effect of SC on Muscle Tone, Range of Motion and Pain

The influence of SC on intrinsic muscle tone and range of motion is presented in Figure 3. Biceps brachii muscle tone was lower with SC than without SC, yet significance was only reached after 30 minutes with SC compared to (1) baseline without SC ($P = .002$) and (2) 30 minutes without SC ($P = .041$). MyotonPRO measurements of rectus femoris muscle tone remained stable during all measurements.

Both elbow and knee maximal extension increased when participants were positioned with SC. After 30 minutes of positioning with SC, elbow extension was significantly increased compared to both baseline without SC ($P = .002$) and 30 minutes of positioning without SC ($P = .006$); a nonsignificant increase in range of motion was noticed compared to baseline with SC ($P = .05$). Knee extension increased immediately after application of SC and increased slightly further during 30 minutes of positioning with SC; however, none of these changes reached the level of significance.

PACSLAC-D ratings of pain during measurements were very low, and the mean [and 95% confidence interval (CI)] ranged from 1.0 (0.4-1.7) to 1.6 (0.9-2.2). No meaningful difference could be found between the multiple measurements ($P = .74$).

Effect of HT on Muscle Tone, Range of Motion, and Pain

The influence of HT on intrinsic muscle tone and range of motion are presented in Figure 4. Both immediately after HT ($P = .015$) and after morning care ($P = .032$), the myotonometric measurements of biceps brachii muscle tone were significantly higher than before HT. In rectus femoris, muscle tone changes were not significant, though a slight increase was found immediately after HT.

Both elbow and knee maximal extension significantly increased after HT ($P < .001$ and $P = .028$ respectively). After performance of morning care, the range of motion decreased again but remained higher than before HT. For elbow extension, this residual gain in range of motion reached significance ($P < .001$).

PACSLAC-D ratings during measurements were again very low, and ranged from 0.9 (0.3-1.4) to 1.1 (0.6-1.6). No meaningful difference could be found between the multiple measurements ($P = .423$).

Effect of HT on Pain and Discomfort During Morning Care

PACSLAC-D ratings of pain during morning care decreased significantly from 4.8 (3.6-5.9) during the control week to 3.5 (2.4-4.7) when morning care was preceded by HT ($P = .003$). Additionally, caregivers reported (1) experiencing lower physical load ($P = .004$), (2) lower estimation of discomfort for the resident ($P = .001$), (3) less hindrance by reduced mobility ($P = .001$), and (4) higher global smoothness ($P = .019$) of morning care in the HT week compared to the control week (Figure 5).

Pain/Discomfort During HT Performance

PACSLAC-D ratings of pain during HT performance were 1.5 (±2.2), suggesting that application of HT was not painful for the participants.

Discussion

The aim of this pilot study was to contribute to evidence-based therapeutic strategies for paratonia by exploring the short-term

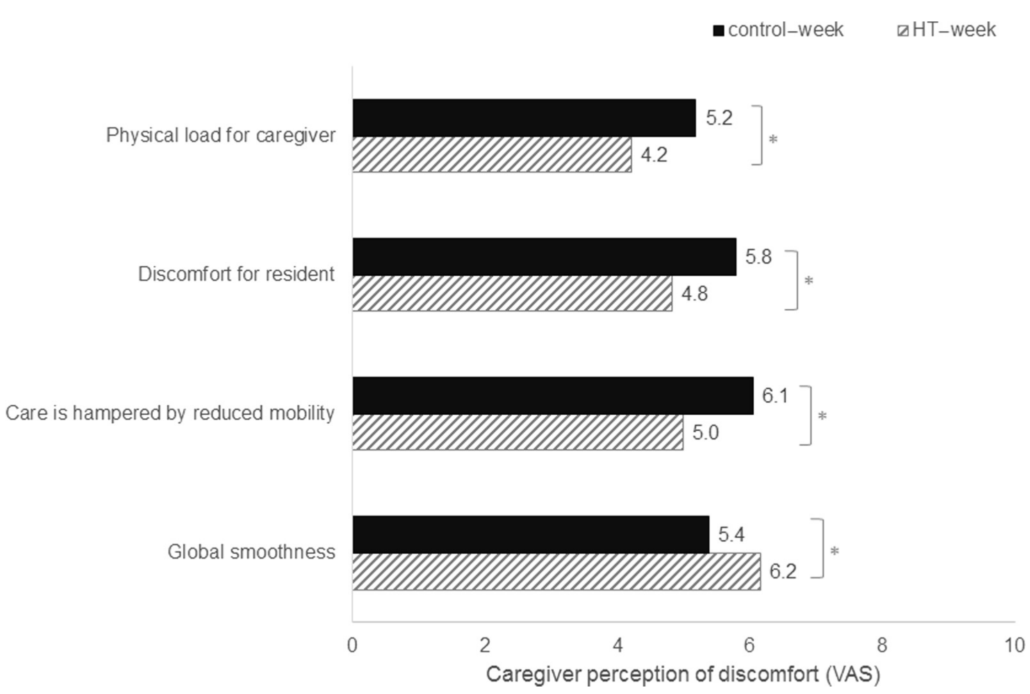

Fig. 5. VAS ratings of discomfort during morning care in control week and HT week. *Significant at .05.

effects of supporting cushions and harmonic techniques in persons with moderate to severe paratonia.

The results of the present study provide evidence for beneficial short-term effect of SC, particularly on the upper limbs of persons with moderate to severe paratonia. The application of SC induced a significant decrease in biceps brachii intrinsic muscle tone and an increase in elbow mobility. Though significant, this decrease did not exceed the minimum detectable change (MDC) values described by Drenth et al.[29] In the lower limb, the effect was even smaller, with a nonsignificant gain in knee extension but no meaningful changes in the intrinsic rectus femoris muscle tone. As we were interested in the concept of positioning as such, any available cushion could be used. Although we are aware that diverse custom-made cushions and positioning systems exist, we did not opt for a specific positioning system because these systems are often expensive and not always available. Further studies and head-to-head comparison should be performed to investigate the eventual benefit of these specific systems. The time span of 30 minutes was arbitrarily chosen. We could not find any studies describing the effect of positioning time on muscle tone changes nor studies reporting the optimal moment for measuring the positioning effect. Future studies should include multiple measurements over a longer period. In addition, the long-term effects of positioning programs and optimal positioning modalities or aids should be further investigated.

A second intervention arm in this study concerned harmonic techniques claiming to induce relaxation, pain gating, and muscle tone reduction.[20] Consequently, lower MyotonPRO muscle tone, higher maximal extension values, and lower PACSLAC-D scores would be expected after HT. In contrast to our expectations, the intrinsic muscle tone was higher whereas the elbow and knee extension deficits significantly decreased after HT. This is remarkable, because it is assumed that in paratonia more passive movement becomes possible when muscle tone decreases.[36] A possible explanation might be that because measurements were performed in the actual resting position, postintervention measurements were usually performed with more extension in the limbs, possibly resulting in a higher passive tension of the muscles.[37] Another hypothetical explanation is that an increase in the range of motion might be mediated by a centrally regulated relaxation. As the MyotonPRO measurements reflect EMG-silent intrinsic muscle tension,[38,39] an eventual centrally induced relaxation might not be captured by the given instrument. Future studies should therefore preferably include additional EMG measurement. It can also be hypothesized that the gain in maximal extension may be caused by plastic changes at (protein) tissue level induced by HT.

From this study, we cannot conclude how long after HT the gain in range of motion is present, because HT was followed directly by daily care. More studies are needed to investigate the effect duration and the long-term effects and to bring more clarity in the effect of HT on local muscle tissue level in persons with paratonia. In addition, it should be mentioned that the beneficial effect was not equal in all participants. Future studies should reveal possible determining factors for treatment effect at an individual level.

During the HT week, in which morning care was preceded daily by 30 minutes of HT, ratings on both PACSLAC-D and comfort perception indicated significantly less pain and discomfort for residents as well as caregivers. This is in contrast to the lack of a significant effect of passive mobilization on pain and caregiver strain reported by Hobbelen et al.[13] Therefore, HT could be an alternative for passive mobilization with respect to facilitating daily care. Yet, more studies are needed to confirm these findings.

Study Limitations

The results of this pilot study should be interpreted with care and in the light of some limitations. Both assessment and intervention were performed in a nursing home setting. As a consequence, environmental factors (eg, background noise) cannot be excluded and could have influenced muscle tone.[1] Participants were recruited from multiple nursing homes. Though no significant differences were found between the different nursing homes, this potential source of bias should be reduced in future studies. Furthermore, both caregivers and researchers were not blinded for the intervention. This might partially account for the registered effect on daily care in contrast to the study by Hobbelen et al[13] and might have allowed possible bias in range of motion and pain measurements. Additionally, it should be remarked that measurements were performed without changing the participant's position, because manipulation can increase paratonia. Most often, however, the limbs were more extended after HT. Consequently, the joint position differed between the multiple measurements. It is not clear to what extent this might have had an impact on MyotonPRO measurements. The impact of muscle length on MyotonPRO measurements should be further explored. Also, the inherent variability of paratonia severity—potentially interfering with the intervention outcome—is a challenge for intervention studies in this population. Yet by including measurement results from 3 separate days, its impact might have been partially counterbalanced. The present study did not investigate the effect of SC and HT on the behavioral and psychological symptoms of dementia, which is an important issue in this population and can be advised to include in future research protocols. Finally, this study examined only the short-term effects of SC and HT. Future studies are recommended to investigate the long-term effects of these interventions.

Conclusion and Implications

This explorative study revealed beneficial short-term effects on the range of motion for both supporting cushions and harmonic techniques, and supporting cushions had an additional positive effect on upper limb muscle tone. A small but significant beneficial effect of harmonic techniques was shown on residents' pain and caregivers' discomfort during care. These encouraging findings should be further confirmed, and the long-term effects of supporting cushions and harmonic techniques should be investigated in future studies. Nevertheless, the results of the present study are a promising step toward the development of evidence-based interventions for paratonia.

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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. Risse SC, Lampe TH, Bird TD, et al. Myoclonus, seizures, and paratonia in Alzheimer disease. Alzheimer Dis Assoc Disord 1990;4:217–225.
3. Yan JH, Rountree S, Massman P, et al. Alzheimer's disease and mild cognitive impairment deteriorate fine movement control. J Psychiatr Res 2008;42:1203–1212.
4. Kikkert LHJ, Vuillerme N, van Campen JP, et al. Walking ability to predict future cognitive decline in old adults: A scoping review. Ageing Res Rev 2016;27:1–14.
5. Tian Q, Chastan N, Bair WN, et al. The brain map of gait variability in aging, cognitive impairment and dementia—A systematic review. Neurosci Biobehav Rev 2017;74:149–162.

6. Tangen GG, Engedal K, Bergland A, et al. Relationships between balance and cognition in patients with subjective cognitive impairment, mild cognitive impairment, and Alzheimer disease. Phys Ther 2014;94:1123–1134.
7. Cieslik B, Jaworska L, Szczepanska-Gierach J. Postural stability in the cognitively impaired elderly: A systematic review of the literature. Dementia (London) 2019;18:178–189.
8. Hobbelen JS, Tan FE, Verhey FR, et al. Prevalence, incidence and risk factors of paratonia in patients with dementia: A one-year follow-up study. Int Psychogeriatr 2011;23:1051–1060.
9. 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.
10. 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.
11. Hobbelen JS, Koopmans RT, Verhey FR, et al. Paratonia: A Delphi procedure for consensus definition. J Geriatr Phys Ther 2006;29:50–56.
12. Souren LE, Franssen EH, Reisberg B. Contractures and loss of function in patients with Alzheimer's disease. J Am Geriatr Soc 1995;43:650–655.
13. Hobbelen JH, Tan FE, Verhey FR, et al. Passive movement therapy in severe paratonia: A multicenter randomized clinical trial. Int Psychogeriatr 2012;24: 834–844.
14. 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;497:573–580.
15. Kleiner-Fisman G, Khoo E, Moncrieffe N, et al. A randomized, placebo controlled pilot trial of botulinum toxin for paratonic rigidity in people with advanced cognitive impairment. PLoS One 2014;9:e114733.
16. Van Deun B, Van den Noortgate N, Saucedo C, et al. Paratonia in Flemish nursing homes: Current state of practice. Am J Alzheimers Dis Other Demen 2018;33:205–214.
17. Van de Rakt J. The development of a fetal position in psychogeriatric patients: A hypothesis. Fysiotherapie en ouderenzorg; 1997:2–6.
18. Hobbelen J, de Bie R, van Rossum E. The effect of passive movement on severity of paratonia: A partially blinded, randomized clinical trial. Nederlands tijdschrift voor Fysiotherapie 2003;113:132–137.
19. Cherry DB. Review of physical therapy alternatives for reducing muscle contracture. Phys Ther 1980;60:877–881.
20. Lederman E. Harmonic Technique. London: Harcourt; 2000.
21. Hegedus EJ, Goode A, Butler RJ, Slaven E. The neurophysiological effects of a single session of spinal joint mobilization: Does the effect last? J Man Manip Ther 2011;19:143–151.
22. Krouwel O, Hebron C, Willett E. An investigation into the potential hypoalgesic effects of different amplitudes of PA mobilisations on the lumbar spine as measured by pressure pain thresholds (PPT). Man Ther 2010;15:7–12.
23. Willett E, Hebron C, Krouwel O. The initial effects of different rates of lumbar mobilisations on pressure pain thresholds in asymptomatic subjects. Man Ther 2010;15:173–178.
24. Pentelka L, Hebron C, Shapleski R, Goldshtein I. The effect of increasing sets (within one treatment session) and different set durations (between treatment sessions) of lumbar spine posteroanterior mobilisations on pressure pain thresholds. Man Ther 2012;17:526–530.
25. Sterling M, Jull G, Wright A. Cervical mobilisation: Concurrent effects on pain, sympathetic nervous system activity and motor activity. Man Ther 2001;6: 72–81.
26. Hobbelen JS, Koopmans RT, Verhey FR, et al. Diagnosing paratonia in the demented elderly: Reliability and validity of the Paratonia Assessment Instrument (PAI). Int Psychogeriatr 2008;20: 840–852.
27. Waardenburg H, Elvers JWH, van Vechgel F, RAB. 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.
28. Van Deun B, Hobbelen JS, Cagnie B, et al. Reproducible measurements of muscle characteristics using the MyotonPRO device: Comparison between individuals with and without paratonia. J Geriatr Phys Ther 2018;41: 194–203.
29. Drenth H, Zuidema SU, Krijnen WP, et al. Psychometric properties of the MyotonPRO in dementia patients with paratonia. Gerontology 2018;64: 401–412.
30. van Rijn SF, Zwerus EL, Koenraadt KL, et al. The reliability and validity of goniometric elbow measurements in adults: A systematic review of the literature. Shoulder Elbow 2018;10:274–284.
31. 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;5:37–49.
32. van Nispen tot Pannerden SC, Candel MJ, Zwakhalen SM, et al. An item response theory-based assessment of the pain assessment checklist for Seniors with Limited Ability to Communicate (PACSLAC). J Pain 2009;10:844–853.
33. Zwakhalen SM, Koopmans RT, Geels PJ, et al. The prevalence of pain in nursing home residents with dementia measured using an observational pain scale. Eur J Pain 2009;13:89–93.
34. 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: 493–502.
35. Reisberg B, Ferris SH, de Leon MJ, Crook T. The Global Deterioration Scale for assessment of primary degenerative dementia. Am J Psychiatry 1982;139: 1136–1139.
36. 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.
37. Gajdosik RL. Passive extensibility of skeletal muscle: Review of the literature with clinical implications. Clin Biomech (Bristol, Avon) 2001;16:87–101.
38. Myoton, Technology. www.myoton.com/technology. Accessed July 2018.
39. Masi AT, Hannon JC. Human resting muscle tone (HRMT): Narrative introduction and modern concepts. J Bodyw Mov Ther 2008;12:320–332.