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Vibration Frequency in Micro-Vibration Therapy in Nursing Care: A Cross-Sectional Study

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Abstract

This study investigated the vibration frequency in micro-vibration therapy (MVT) performed as a part of nursing care in Japan. We surveyed 31 nurses (25 women and 6 men) who performed MVT with accelerometers attached to the backs of their hands, and the data obtained were analyzed. The mean vibration frequency was 8.3 Hz (standard deviation [SD]: 1.9 Hz) bilaterally, with a left-right difference of 0.8 Hz (SD: 1.1 Hz, right > left). Furthermore, vibration frequency was correlated with duration of MVT use ($rs = 0.5$, $P < 0.01$). The vibration frequency was higher in men (9.2 Hz, SD: 2.4 Hz) than in women (8.1 Hz, SD: 1.8 Hz), but this difference was not significant ($P = 0.34$). The vibrations of MVT are of a lower frequency than those of other vibration therapies.

Keywords

Micro-Vibration Therapy, Nursing Care, Vibration Frequency

1. Background

Research on vibration therapy has recently received a great deal of attention. Vibration therapy is mainly classified as whole-body vibration therapy or local vibration therapy. The effects of local vibration therapy include vasodilation and increased blood flow [1] [2], improved wound healing [3] [4], and pain relief [5] [6]. These reports are investigations of instrumental vibration, and there are few

reports on direct hands-on vibration care.

Micro-vibration therapy (MVT), the focus of this study, is a local vibration therapy performed by hand without the use of machines. In this caregiving technique, the practitioner places both their hands on the target area and actively vibrates them. The effect of MVT varies depending on the target area. MVT on the back of the thorax helps with sputum flow, and over the lumbar buttocks, it helps with constipation [7]. It is also used to relieve muscle tension in various parts of the body and to improve contractures. In Japan, it is mainly used for patients with prolonged consciousness disorder and disuse syndrome. However, MVT is often used in combination with other techniques; thus, it is not evaluated separately. Moreover, there are no reports that have accurately investigated the vibratory properties of MVT. For accurate assessment, the vibration frequency in MVT should be investigated and compared with that in other vibration therapies. Therefore, the purpose of this study was to investigate the characteristics, mainly vibration frequency, of MVT using accelerometers.

2. Method

2.1. Study Design and Setting

This cross-sectional study was conducted in Himeji, Kyoto, and Akita from April to June 2017. The study was approved by the Bioethics Committee of Himeji Dokkyo University (No.16-05). Written informed consent for the study was obtained from all the participants.

2.2. Participants

The participants were volunteers recruited from the community associated with MVT. The selection criteria for the target participants were nurses who had attended training on MVT or had received direct instruction from an MVT trainer. Nurses using MVT were included in the study. Participants with any form of upper extremity pain or pre-existing musculoskeletal or neural conditions (such as fractures, dislocations, nerve damage, or joint diseases) that could potentially affect their ability to perform the MVT technique were excluded from the study.

2.3. Data Collection

Each participant assumed a seated position in a chair, with their feet planted firmly on the ground separated by a 10 - 20 cm gap between the legs. MVT was performed by vibrating the palms of both the hands on the nurse's own thighs (**Figure 1**). The nurses wore gloves with accelerometers (TSND121, ATR-Promotions, Japan) attached to the back of both the hands. The measurement time was 20 seconds (5 seconds before and after MVT performance and 10 seconds when the MVT was being performed), acceleration range was ±8 G, sampling period was 5 ms, and average sampling frequency was 1 Hz. Information on sex, age, and duration of MVT use was obtained through questionnaires.

Figure 1. Sitting position for MVT measurement.

2.4. Statistical Analyses

Frequencies and power spectral density were calculated from the vibration waveforms by fast Fourier transform (window function: Hamming) using Sensor Data Analyzer (ATR-Promotions, Japan), and amplitudes (mm) were calculated from the acceleration (m/s^2) and frequency (Hz). Spearman's rank correlation coefficients were calculated to determine the correlations of vibration frequency with age and duration of MVT use. Spearman's coefficients are denoted by rs. The Brunner-Munzel test was used to compare the vibration frequency by sex. The level of significance was set to <5%, and statistical analyses were performed using Bell Curve for Excel version 2.13 (Social Survey Research Information Co. Ltd., Japan).

3. Results

3.1. Participant Characteristics

Of the 35 nurses originally recruited, 4 were excluded due to missing data; thus, 31 nurses were included in the analysis. The included participants comprised 25 women and 6 men with a mean age of 50.2 years (standard deviation [SD]: 9.9 years) and mean duration of MVT use of 4.9 years (SD: 4.3 years).

3.2. Acceleration and Frequency of Vibration

The MVT vibration frequencies of the participants are shown in Figure 2 and Figure 3. The mean vibration frequency in MVT for both hands, right hand, and left hand were 8.3 Hz (SD: 1.9 Hz), 8.4 Hz (SD: 1.9 Hz), and 8.2 Hz (SD: 2.1 Hz), respectively. The difference in vibration frequency between the right and left hands was 0.8 Hz (SD: 1.1 Hz), with the right hand tending to have a slightly higher frequency than the left hand; although this difference was not statistically significant (P = 0.7). The vibration frequency was higher in men (9.2 Hz, SD: 2.4

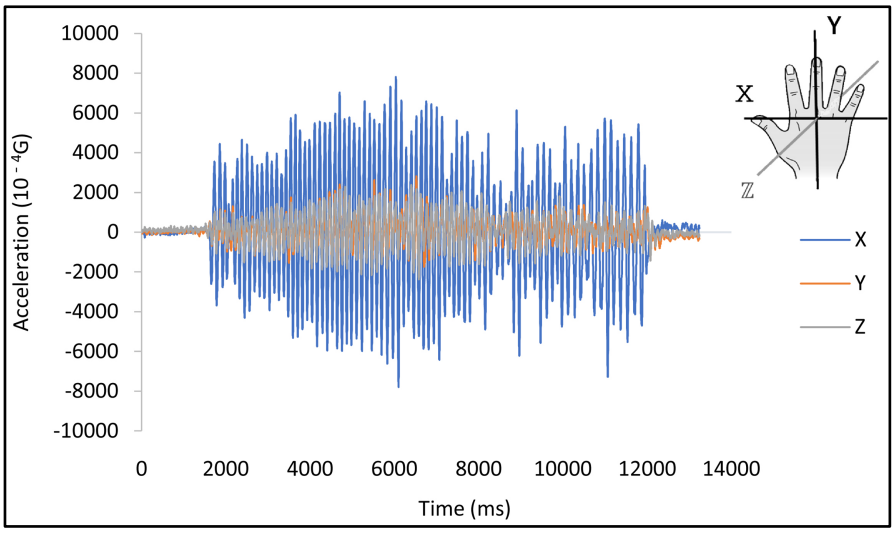

Figure 2. Waveform of the acceleration component of micro-vibration therapy.

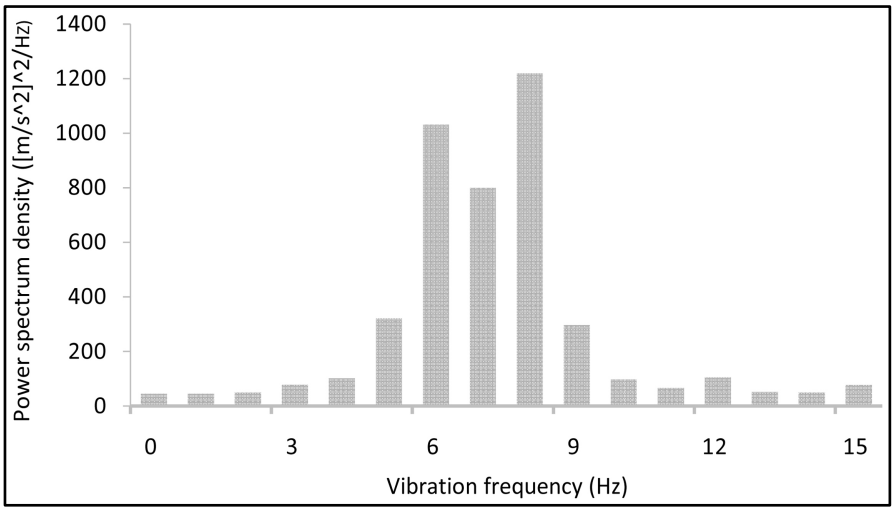

Figure 3. Relationship between the vibration frequency and power spectrum density of micro-vibration therapy.

Table 1. Rank correlation between vibration frequency and participant attributes (N = 31).

Variables	1	2	3	4	5	6
1) Frequency (right hand)	-					
2) Frequency (left hand)	0.73**	-				
3) Frequency (both hands)	0.92**	0.92**	-			
4) Frequency (left-right difference)	−0.02	−0.62**	−0.37*	-		
5) Age	−0.16	−0.12	−0.10	−0.06	-	
6) Duration of MVT use	0.37*	0.55**	0.5**	−0.4*	0.21	-

*P < 0.05, **P < 0.01.

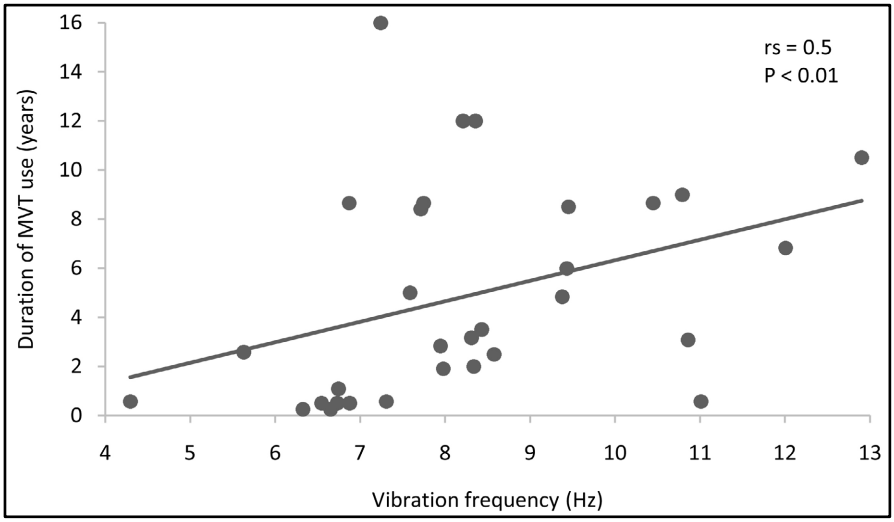

Figure 4. Correlation between duration of MVT use and vibration frequency; MVT: micro-vibration therapy.

Hz) than in women (8.1 Hz, SD: 1.8 Hz), although this difference was not statistically significant (P = 0.34). The vibration amplitude was 3 - 5 mm. Analysis of the acceleration waveforms by component revealed that X-axis acceleration tended to be relatively high.

3.3. Correlation of Vibration with Attributes

The correlation between vibration frequency and age and duration of MVT use are presented in Table 1. Age was not correlated with vibration frequency and duration of MVT use. Vibration frequency was positively correlated with duration of MVT use (rs = 0.5, P < 0.01) (Figure 4).

4. Discussion

The vibration frequency and amplitude in local vibration therapy reportedly range from 5 to 300 Hz and from 0.12 to 12 mm, respectively [8]. The mean vibration frequency in MVT observed in this study was 8.3 Hz, which is lower than that of other vibration therapies. The vibration showed a relatively high acceleration in the X-axis, indicating that the vibration was in the lateral direction.

Reports of accelerometer-measured physiological tremors at four sites (finger, hand, forearm, and upper extremity) indicate that each site has a common peak frequency of approximately 10 Hz, along with another peak frequency that decreases as the mass of the body part increases, which is approximately 6 Hz for the hand [9]. In another study of vibrations with a 10-Hz peak frequency, the power spectrum density increased as weight loading was applied, and this frequency band was considered to represent voluntary muscle activation [10]. These findings show many similarities with our results. Therefore, we can consider that MVT involves the voluntary tensing of muscles to vibrate the hand and that load is applied when vibration with a peak frequency of approximately 10 Hz is performed.

Practitioners who have been performing MVT since a long time may be voluntarily applying some load and tensing their muscles; that is, they may be vibrating their hands with force. In contrast, practitioners who have recently started performing MVT may vibrate their hands by moving them from side to side without applying much load and with a low vibration frequency. We believe that some practitioners require practice to generate vibrations using their hands by tensing their muscles, which might explain the positive correlation between the duration of MVT use and vibration frequency.

This study has few limitations. The study's limited scope, which only investigated MVT performed by nurses in Japan, may limit the generalizability of the results to other populations or contexts. Therefore, caution should be exercised when interpreting the findings of this study and further research is needed to confirm and expand upon these results. Moreover, while this study examined the vibration frequency in MVT, the most effective frequency range for care remains unknown, as we could not compare the effectiveness of different frequencies. Furthermore, it was not determined whether relatively high frequencies, which are generated by long-time MVT practitioners, are more effective than low frequencies. Nevertheless, vibration therapy with a peak frequency of 10 Hz, which is close to the frequency of micro-vibration, could be used as a part of care through touch. In the future, we aim to verify the effectiveness of MVT, investigate whether there are differences based on frequency, and contribute to the improvement of MVT techniques.

5. Conclusion

The present study found that the mean bilateral vibration frequency in MVT performed as part of nursing care in Japan was 8.3 Hz, with a left-right difference of 0.8 Hz. The duration of MVT use was positively correlated with vibration frequency. Additionally, even though men had a slightly higher frequency than women, the difference was not significant. Further research is needed to explore the potential clinical benefits of MVT and how it can be optimally applied in nursing care.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Nakagami, G., Sanada, H., Matsui, N., Kitagawa, A., Yokogawa, H., Sekiya, N., *et al.*

(2007) Effect of Vibration on Skin Blood Flow in an *in Vivo* Microcirculatory Model. *Bioscience Trends*, **1**, 161-166.

[2] Wong, A., Sanchez-Gonzalez, M.A., Gil, R., Vicil, F., Park, S.Y. and Figueroa, A. (2012) Passive Vibration on the Legs Reduces Peripheral and Systemic Arterial Stiffness. *Hypertension Research: Official Journal of the Japanese Society of Hypertension*, **35**, 126-127. https://doi.org/10.1038/hr.2011.164

[3] Arashi, M., Sugama, J., Sanada, H., Konya, C., Okuwa, M., Nakagami, G., *et al.* (2010) Vibration Therapy Accelerates Healing of Stage I Pressure Ulcers in Older Adult Patients. *Advances in Skin & Wound Care*, **23**, 321-327. https://doi.org/10.1097/01.ASW.0000383752.39220.fb

[4] Pongkitwitoon, S., Weinheimer-Haus, E.M., Koh, T.J. and Judex, S. (2016) Low-Intensity Vibrations Accelerate Proliferation and Alter Macrophage Phenotype *in Vitro*. *Journal of Biomechanics*, **49**, 793-796. https://doi.org/10.1016/j.jbiomech.2016.01.027

[5] Canbulat, N., Ayhan, F. and Inal, S. (2015) Effectiveness of External Cold and Vibration for Procedural Pain Relief during Peripheral Intravenous Cannulation in Pediatric Patients. *Pain Management Nursing: Official Journal of the American Society of Pain Management Nurses*, **16**, 33-39. https://doi.org/10.1016/j.pmn.2014.03.003

[6] Su, H.-C., Hsieh, C.-W., Lai, N.M., Chou, P.-Y., Lin, P.-H. and Chen, K.-H. (2021) Using Vibrating and Cold Device for Pain Relieves in Children: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Journal of Pediatric Nursing*, **61**, 23-33. https://doi.org/10.1016/j.pedn.2021.02.027

[7] Kamiya, K. and Harakawa, J. (2011) Nursing Exercise for Physical Adjustment. Nursing Science Academy.

[8] Germann, D., El Bouse, A., Shnier, J., Abdelkader, N. and Kazemi, M. (2018) Effects of Local Vibration Therapy on Various Performance Parameters: A Narrative Literature Review. *The Journal of the Canadian Chiropractic Association*, **62**, 170-181.

[9] Takanokura, M. and Sakamoto, K. (2001) Physiological Tremor of the Upper Limb Segments. *European Journal of Applied Physiology*, **85**, 214-225. https://doi.org/10.1007/s004210100476

[10] Miao, T. and Sakamoto, K. (1995) Effects of Weight Load on Physiological Tremor: The AR Representation. *Applied Human Science: Journal of Physiological Anthropology*, **14**, 7-13. https://doi.org/10.2114/ahs.14.7