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SHORT COMMUNICATION

Analysis of the Impact of Tourmaline and Terahertz-Infused Clothing on Heart Rate Variability

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Abstract

Introduction: Expanding upon prior investigations that identified advantageous Far Infrared (FIR) properties associated with two minerals, namely tourmaline and terahertz, across diverse domains, including health and medicine. This study explores the impact of incorporating fine powders of these minerals into printing ink for patterns on shirts on HRV when wearing the shirts.

Methods: A total of 12 healthy adult males were surveyed in this study. Fine powders of the two minerals, tourmaline, and terahertz were incorporated into printing ink and used to print patterns on shirts. The impact of wearing these shirts on HRV was observed.

Result: The significant differences in time-domain analysis parameters such as SDRR and RMSSD, frequency-domain analysis parameters including Total (ms2), VLF (ms2), LF (nu), HF (ms2), and nonlinear analysis parameters SD1 and SD2 were observed.

Conclusion: The findings suggest that both short-term and long-term wear of shirts containing these minerals lead to an increase in vagal nerve tension. Participants wearing shirts with mineral inclusions exhibited changes related to vagal nerve activity.

Abbreviations

HRV: Heart Rate Variability; RMSSD: Root Mean Square of Successive Differences; SDRR: Standard Deviation of RR Intervals; pRR50: Percentage of RR intervals greater than 50 milliseconds; VLF: Very Low Frequency; LF: Low Frequency; HF: High Frequency; SD1: Standard Deviation of Short-Term Variability; SD2: Standard Deviation of Long-Term Variability

Introduction

Heart Rate Variability (HRV) serves as a crucial indicator of stress and health, providing a window into the peripheral physiology of behavioural adaptability [1]. Through the exploration of new therapeutic methods to reduce stress levels, individuals strive to minimize the associated risks with adverse health conditions [2].

Tourmaline is a unique mineral with electrifying properties that

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transform body heat into infrared radiation within the range of 3-20 micrometres when heated. This has a positive impact on increasing blood flow, improving microcirculation, and enhancing immune function [3-5].

Terahertz stone emits a vibration known as "terahertz waves," with a frequency like far-infrared radiation. When terahertz waves are directed towards the human body or substances, they may induce resonance phenomena, thereby increasing body temperature and vitality [6,7].

This research combines tourmaline and terahertz, printing them onto shirts, to explore the potential effects on individual heart rate variability when wearing shirts adorned with patterns of these two minerals.

Methods

This study, approved by the Ethics Committee of the Nihon Pharmaceutical University (Approval Number: JPU-3-18), aims to investigate the impact of mineral-infused shirts on Heart Rate Variability (HRV). Healthy male participants were recruited and provided written consent after detailed explanations. Two shirts with identical patterns were used, one containing a 1:1 ratio of Tourmaline and Terahertz with a particle size of 325 mesh, and the other without any minerals. The experiment was conducted in a crossover randomized double-blind manner, involving wearing the shirts, continuously for one week, with a shirt exchange every week. Participants underwent a 5-minute HRV test in a seated, eyes-open state, recorded by the PowerLab system, and data analysis was performed using LabChart Pro 7.0 and HRV v2.0.

Statistical analysis employed independent samples t-tests, with a significance level set at $\alpha < .05$ [8].

Results and Discussion

The study involved 12 male participants with an average age of 53 ± 12 years, wearing the shirts for over 23 hours daily for a continuous period of 14 days. Various indicators representing autonomic nervous system Heart Rate Variability (HRV) were assessed.

The results of this study demonstrate that wearing mineral-infused shirts containing Electric Stone and Terahertz stone has a notable effect on HRV. The European Society of Cardiology recommends using Root Mean Square of Successive Differences (RMSSD) for short-term HRV assessment, with Low Frequency/High Frequency (LF/HF) reflecting sympathetic and parasympathetic nervous system activity [9]. The RMSSD method is preferred as it is less influenced by respiratory rate, heart rate, or recording duration [10], primarily reflecting parasympathetic nervous system activity [10,11].

The study results indicate a significant increase in average RMSSD when wearing mineral-infused shirts containing Tourmaline and Terahertz stone, suggesting an elevation in vagal nerve tension after wearing these shirts (Table 1). This aligns with literature indicating that Tourmaline products can raise body temperature and induce relaxation [12-15].

The study also notes a decrease in LF power, which is considered an indicator of stress reflex function. While stress typically increases sympathetic nervous system components, resulting in an increase in LF and LF/HF ratio [16], the current study observes a decrease in LF, reaching statistical significance (Table 1). This decrease in LF, along with reductions in indicators of parasympathetic nerve activity Standard Deviation of the RR interval (SDRR), Percentage of RR intervals greater than 50 milliseconds (pRR50), and Standard

Table 1: Meaning and average values with standard deviation of various indicators of HRV.

Item/Group	No ore group	ore group
Average Heart Rate	64 ± 10.01	64.5 ± 10.39
Time Domain Analysis		
Average RR (ms)	914.8 5 ± 93.53	923.58 ± 124.98
SDRR (ms)	39.73 ± 8.82	44.31 ± 12.22*
RMSSD (ms)	31.49 ± 9.39	36.25 ± 12.7*
pRR50 (%)	11.32 ± 8.66	14.89 ± 13.3
Frequency Domain Analysis		
VLF (ms2)	569.05 ± 336.37	748.38 ± 566.97*
VLF %	41.89 ± 13.81	41.4 ± 16.38
LF (ms2)	409.24 ± 219.59	455.92 ± 273.71
LF %	29.4 ± 10.1	26.3 ± 11.2
LF (nu)	50.31 ± 11.22	45.45 ± 15.69*
HF (ms2)	376.88 ± 177.83	519.44 ± 302.16***
HF %	28.4 ± 9.07	30 ± 11.7
HF (nu)	48.92 ± 11.23	52.11 ± 13.44
LF/HF	1.12 ± 0.48	1.03 ± 0.58
Non-linear Indices		
SD1	22.3 ± 6.65	25.7 ± 90*
SD2	51.4 ± 11.3	56.7 ± 16.7*

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Deviation of short-term variability (SD1) Standard Deviation of long-term variability (SD2) (Table 1), suggests that wearing mineral-infused shirts is associated with increased parasympathetic nervous system activity, relaxation, and reduced stress.

Additionally, previous studies have shown that fabrics woven with Tourmaline can promote parasympathetic dominance [14], and similar research in bedding has demonstrated the predominant role of the parasympathetic nervous system [15].

Non-linear indices, such as SD1 and SD2, are commonly used as supplementary measures of HRV [8]. Poincaré plot descriptors of RR intervals have been found to be significantly correlated with measures of Spontaneous Baroreflex Sensitivity (BRS) and major HRV indices, indicating physiological and psychological stress and pressure [17,18]. The study reveals a significant increase in both SD1 and SD2 after wearing mineral-infused shirts (Table 1), indicating short-term and long-term effects on HRV.

However, it's important to note that this study is limited to comparing the effects of wearing and not wearing mineral-infused shirts. Further research is warranted to delve deeper into the observed effects. Overall, these findings provide positive insights into the impact of mineral-infused shirts on heart rate variability.

Conclusion

Based on the comprehensive study results, wearing shirts infused with finely powdered Tourmaline and Terahertz stone appears to induce subtle changes in the heart rate variability of participants, including an increase in the activity of the autonomic nervous system. This suggests that mineral-infused shirts may have a potential impact on promoting relaxation and alleviating stress. While preliminary results indicate physiological effects of this specific clothing, further research and validation are necessary. This study serves as a noteworthy starting point for future in-depth research on the physiological effects of wearing similar garments.

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