EFFECTS OF MODIFIED TRANSCUTANEOUS ELECTROMAGNETIC FIELD IRRADIATION ON ACUTE HEART RATE VARIABILITY RESPONSES

Osvaldo Soares de Araújo Júnior[1]
Larissa Gomes dos Santos[1]
Patricia Sardinha Leonardo[2]
Rodrigo Alvaro B. Lopes Martins[2]
Alberto Souza de Sá Filho[2]

Medical Student at the Evangelical University of Goiás[1]
Graduate Program in Human Movement and Rehabilitation, Evangelical University of Goiás – UniEVANGÉLICA[2]

ABSTRACT

Introduction: Photobiomodulation is a non-thermal therapy that uses light in the visible spectrum and interacts with cells and tissues, being absorbed by mitochondrial chromophores. The application of photobiomodulation for the analysis of cardiac physiological parameters, especially HRV, represents a pioneering field of study that warrants further investigation. **Objective:** to analyze the acute effect of ILIB (Intravascular Laser Irradiation of Blood) therapy on heart rate variability (HRV) outcomes in the time domain. **Methodology:** 20 participants of both sexes, aged between 18 and 60 years, were included in the sample. The study was conducted in three visits: the first to collect baseline physiological data, and the two subsequent visits randomized for the application of radial ILIB or placebo. **Results:** HRV was analyzed in the time domain, and the results showed a significant reduction in resting HR (p=0.0024) and an increase in RR interval variability (p=0.0047) induced by ILIB. The SDNN variable also increased after the ILIB irradiation intervention (p=0.012), however, there were no significant differences between interventions for the RMSSD variable (p=0.081). **Conclusion:** The results suggest promising effects of ILIB on HRV modulation. However, there are discrepancies in the results between the different HRV variables, indicating the complexity of the mechanisms involved in cardiovascular function.

Keywords: Photobiomodulation; Heart Rate Variability; ILIB; Health.

INTRODUCTION

Photobiomodulation is a non-thermal therapy that uses light in the visible spectrum (400-700 nm) and near infrared (700-1100 nm), employing lasers, light-emitting diodes, and/or broadband light[1,2]. This technique interacts with cells and tissues, being absorbed by mitochondrial chromophores, resulting in increased ATP production and protein synthesis [3].

Heart rate variability (HRV) is a crucial indicator of cardiac autonomic modulation, reflecting the balance between the sympathetic and parasympathetic nervous systems. Its changes provide valuable insights into cardiovascular health and the state of autonomic regulation.[5,6] The application of photobiomodulation for the

analysis of cardiac physiological parameters, especially HRV, represents a pioneering field of study. To date, there are no published studies in literature that specifically investigate the effects of radial ILIB (Intravascular Laser Irradiation of Blood) on HRV during electrocardiogram (ECG) readings. This study aims to fill this gap in literature by analyzing the acute effect of ILIB radial artery irradiation therapy on HRV outcomes in the time domain.

METHODS

For this randomized controlled clinical trial, 20 participants of both sexes, whether physically active or not, with low risk according to the risk stratification criteria proposed by the ACSM (American College of Sports Medicine) and non-smokers were invited to participate in this study. Participants were recruited via public calls at a university located in central-western Brazil. The study was conducted during the second half of 2023 until October 2024.

For this study, we determined that a sample of 20 participants would be adequate to achieve our research objectives. We used a significance level of 0.05 and a statistical power of 80%, adjusting the variability parameters and the minimum detectable difference to ensure the validity of the results with this number of participants. This sample size was considered sufficient to provide reliable and robust results, allowing for adequate statistical analysis and generalization of the findings to the study population.

To avoid possible analysis biases, data were collected by a single evaluator (O.S.) who blinded the data spreadsheet. A second researcher (group leader) was responsible for statistical analysis and production of results, remaining blind throughout the data collection process.

Inclusion criteria: participants without diagnosed hemodynamic and cardiovascular changes and who did not use sympatholytic drugs. Exclusion criteria: participants who used substances that alter the cardiovascular system or are at high risk. All participants signed the free and informed consent form (FICF), in accordance with Resolution 466/2012 of the National Health Council. The study was approved by

the research ethics committee of the Evangelical University of Goiás (opinion number 6,651,115 – CAAE: 72880823.0.0000.5076).

The baseline was established with a first experiment with HRV analysis, establishing the time needed for relaxation for subsequent analyses. After the first visit, participants were randomly assigned to two different procedures, performed on separate visits: a) radial irradiation (ILIB); b) placebo radial irradiation (PLA).

During the experimental visits, participants remained at rest for 15 min with HRV analysis, followed by 15 min of ILIB or PLA irradiation. The procedures were performed with participants blindfolded, in a supine position, at a controlled temperature (± 23°C) and in a closed room with minimal influence from external noise.

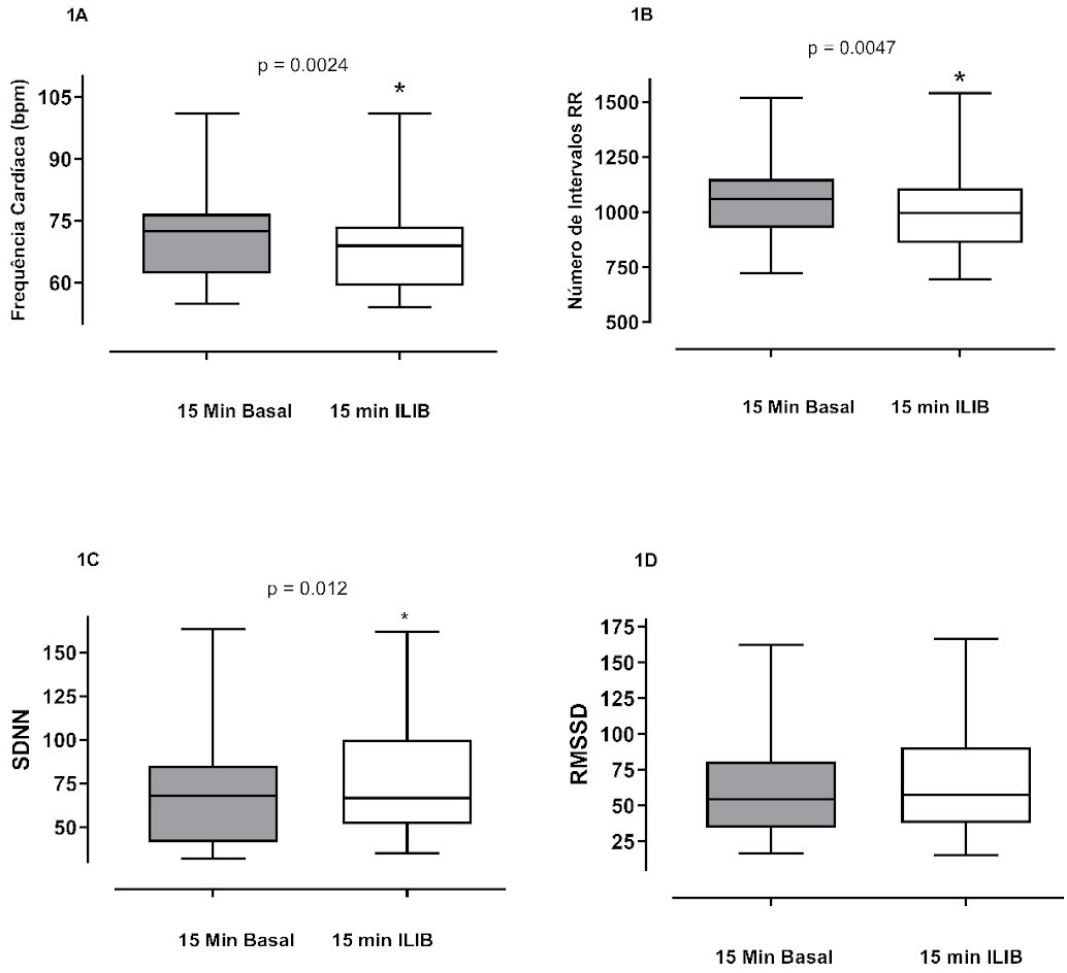
HRV was collected by a digital electrocardiogram module ECGPC (Tecnologia Eletrônica Brasileira "TEB" – ANVISA Registration 10265690026). Time domain parameters were analyzed: mean HR (bpm), total RR intervals, SDNN (standard deviation of normal-to-normal RR intervals), RMSSD (root mean square of successive RR interval differences).

Statistical analysis included logarithmic transformation for data normalization and repeated measures ANOVA to compare experimental procedures. Data were presented as mean ± standard deviation (SD). The level of significance was set at $p = 0.05$.

RESULTS

The application of radial ILIB demonstrated significant effects on HRV modulation compared to placebo. The significant reduction in resting heart rate after ILIB intervention suggests a possible improvement in cardiac autonomic regulation, indicating a potentially beneficial effect of this technique on cardiovascular function[4,5,6].

Figure 1. Comparison of HRV measures in the time domain



Source: authors

The change in RR interval variability induced by ILIB indicates greater flexibility of the cardiovascular system in response to internal and external stimuli. This finding, corroborated by the significant increase in the SDNN variable (standard deviation of normal-to-normal RR intervals), suggests that ILIB may promote an improvement in overall HR variability, which is generally associated with better cardiovascular health and the body's ability to adapt [4,6]

However, it is important to note that there was no statistically significant difference for the RMSSD variable (root mean square of successive RR interval differences) between the interventions. This result suggests that the effect of ILIB may not be uniform in all aspects of HRV. This raises questions about the specific mechanisms by which ILIB affects cardiac autonomic regulation and indicates the need for further research to fully understand its effects[1,2,3] .

CONCLUSION

Radial ILIB demonstrated promising effects on HRV modulation compared to placebo. Significant reduction in resting heart rate and increase in RR interval variability suggest a potential beneficial effect on cardiac autonomic regulation. Although a significant increase in the SDNN variable was observed, the absence of a difference in the RMSSD variable between interventions suggests that the effect of ILIB may not be uniform in all aspects of HRV.

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