Oscillation intervals of cutaneous blood perfusion as indicators of aging

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Short Report

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Oscillation intervals of cutaneous blood perfusion as indicators of aging

Short title: Cutaneous perfusion oscillation interval and aging

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Abstract：

A total of 30 healthy participants (Old, aged >40 years, n=12; Young, age<40, n=18) were recruited, and their bilateral upper limb blood flow was recorded. The results showed that on either the left or right side, the average oscillation intervals of the lower age were significantly higher than those of the older age and that on the left or right side, the average interval was negatively and weakly correlated with age. The current study provides a window to access age-related changes on the oscillation interval of cutaneous laser Doppler flowmetry.

Key words: laser Doppler blood flowmetry, oscillation interval, heart rate variability

Abbreviations: CVD, cardiovascular disorders; LDR, laser Doppler blood flowmetry

Cardiovascular disorders (CVD) are related to reactive microcirculation damage. Age-related changes in microcirculatory function are associated with the progression of CVD[1]. Laser Doppler flowmetry (LDF) is a reliable technique for assessing microvascular function. A previous study has demonstrated that the time-amplitude characteristics of oscillatory components depend on age-related changes[2].

However, the LDF signal is a periodic signal, and the information is contained in not only the time amplitude but also the beat-to-beat intervals. Moreover, the oscillation interval of the LDF is determined mainly, but not completely, by the heart rate. Therefore, the oscillation interval analysis of the LDF cannot be completely replaced by a heart rate variability analysis.

In this study, we conducted an observational study to assess the impact of age-related changes on the oscillation interval of cutaneous LDF.

A total of 30 healthy participants (aged >40 years, n=12; young, age<40 years, n=18) were recruited for this study. Following a period of cardiovascular stability (40 min) after arrival at the laboratory, upper limb blood perfusion signals were recorded for at least 15 min with a 64 Hz sample rate. Considering that there may be left-right differences in cutaneous LDF[3], bilateral upper limb blood flow was recorded simultaneously (Figure [A]). The outliers were removed from the raw signal, and low-pass filtering (Figure [B]) was performed. The filtered blood flow signal was normalized, and the peaks were accordingly identified (Figure [C]). Thus, the time series of blood perfusion oscillations was obtained. The distribution of the intervals is shown in Figure [D].

The data that support the findings and scripts used in this study are deposited in Figshare (https://doi.org/10.6084/m9.figshare.16384077.v1).

After obtaining the oscillation intervals, the average intervals of different ages and sides were calculated. The results showed that for either the left or right side, the average oscillation intervals of the lower age were significantly higher than those of the older age (Figure [E]).

To further explore the relationship between oscillation intervals and age, Spearman correlation analysis was performed between either side of average interval and age. The results showed that on the left or right side, the average interval was negatively and weakly correlated with age (Figure [F]).

The major limitation is that only one part of the blood flow was recorded on each side. The second limitation was that the electrocardiograms were not recorded synchronously. Therefore, it is impossible to analyze the relationship between heart rate variability and the oscillation intervals of cutaneous LDF simultaneously.

In conclusion, these results suggest that the oscillation intervals on either side decreases with age-related changes. The present study allows for the assessment of age-related changes on the oscillation interval of cutaneous LDF.

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Disclosures

None.

References

1. van de Hoef TP, Echavarria-Pinto M, Meuwissen M, Stegehuis VE, Escaned J, Piek JJ. Contribution of age-related microvascular dysfunction to abnormal coronary: Hemodynamics in patients with ischemic heart disease. *JACC Cardiovasc Interv*. 2020;13:20-29. doi:10.1016/j.jcin.2019.08.052.
2. Tikhonova IV, Tankanag AV, Chemeris NK. Age-related changes of skin blood flow during postocclusive reactive hyperemia in human. *Skin Res Technol*. 2013;19:e174-181. doi:10.1111/j.1600-0846.2012.00624.x.
3. Jia S, Wang Q, Li H, Song X, Wang S, Zhang W, Wang G. The relationship between blood perfusion in the lower extremities and heart rate variability at different positions. *Frontiers in Physiology*. 2021;12. doi:10.3389/fphys.2021.656527.

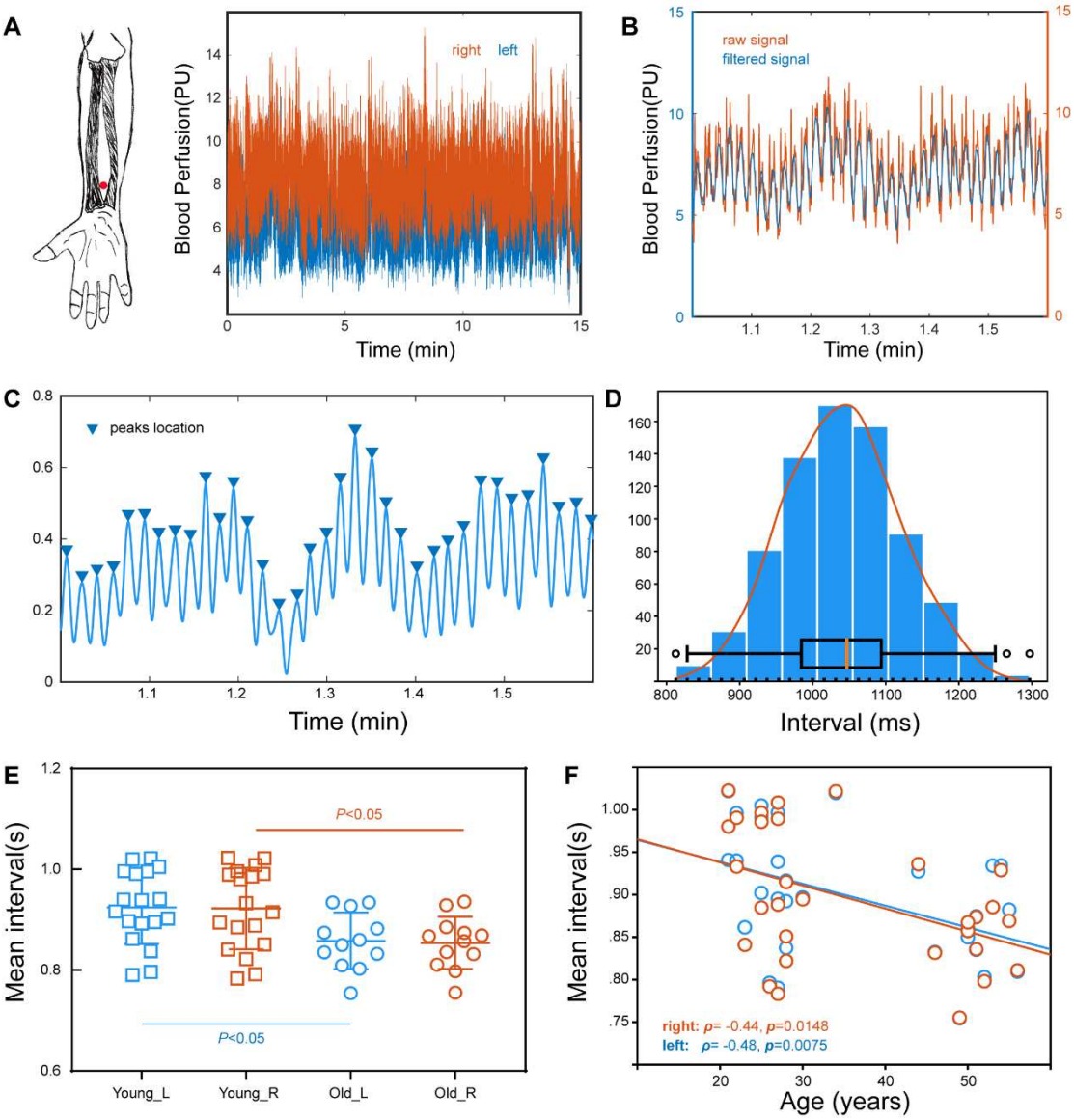

Figure. Difference in oscillation intervals of cutaneous laser doppler flowmetry (LDF) between different age participants

[A] Record point marked as a red dot (left) and raw signals (right)

[B] Raw signal (red) was filtered using a low-pass filter

[C] Peak location of the normalized signals

[D] Distribution of the oscillation intervals

[E] Average intervals of different sides and participants of different ages

[F] Spearman correlation analysis between intervals and age.

ρ, Spearman's correlation coefficient

All P-values were corrected by false discovery rate (FDR)