The Joint Meeting between the German Society for Microcirculation and Vascular Biology and the British Microcirculation and Vascular Biology Society

An evaluation of the association between skin microcirculation and temperature in light of the autonomic functions of the small nerve fibres in the foot

Gayathri Balasubramanian, Nachiappan Chockalingam, Roozbeh Naemi

Centre for Biomechanics and Rehabilitation Technologies, Staffordshire University, 32 Leek Rd, Stoke-on-Trent ST4 2RU

Email: gayathri.balasubramanian@research.staffs.ac.uk

Introduction

Microvascular complications in the foot are directly associated with small fibre dysfunction, and vice versa (Körei et al., 2016; Vas et al., 2012; Veves et al., 2006), but there is a lack of studies focused on understanding the relationship between the two and the mechanisms that underpin their interactions. This knowledge would help identify non-invasive assessments that may potentially be relevant in the treatment of clinical diseases, such as diabetic foot complications. Therefore, this study aimed to understand the relationship between autonomic functions of the small nerve fibres and microcirculation in the foot using non-invasive methods.

Methods

The study was conducted after approval from the University Ethics Committee. The inclusion criteria were: adults without severe neurological or vascular issues, major trauma/injury, bleeding, bruising, haematoma and fractured bones. Participants were recruited using a convenience sampling method and were asked not to consume caffeinated/alcoholic beverages, and not to exercise two hours before participation, as this is known to affect physiological measures. The mean (SD) age of the participants was 23.8 (4.37) years, and their BMI was 24.53 (7.63) Kg/m2. Participants lay on a couch in the biomechanics lab in a temperature-controlled room of 23C + / - 1 during the experiments. Microcirculatory perfusion (PU) and temperature (T) parameters were collected using laser Doppler flowmetry (LDF) Perimed Periflux® system 5000. BIOPAC system was used to measure heart rate (HR) and electrodermal activity parameters (EDA) of the autonomic functions of the nervous system, and all parameters were measured synchronously during a baseline, inspiratory and expiratory phase.

Results/Discussion

Spearman rho correlation analysis showed that PU and T had a strong to very strong positive correlation in the right foot (Inspiration $r = 0.855$; $p = 0.002$; expiration $r = 0.818$; $p = 0.004$) and left foot (baseline $r = 0.758$; $p = 0.011$; inspiration $r = 0.782$; $p = 0.008$; expiration $r = 0.758$; $p = 0.011$). A partial correlation analysis showed that HR and EDA had very little effect on the correlation between PU and T. A regression analysis showed that T was a strong and significant predictor of PU ($p < 0.05$).

Knowledge of the variations due to thermoregulatory mechanisms in a thermoneutral environment is minimal, although studies have examined the neurogenic aspects and nitric oxide aspects, which mediate microcirculatory response during rapid and slow local heating, respectively. This study bridged this gap and investigated the relationship between PU and foot temperature during autonomic activity (deep breathing). PU and T in the foot had a strong, monotonic and positive relationship; HR and EDA had little influence on this relationship. Moreover, T is a predictor of microcirculation.

Conclusions

This study has shown that microcirculation and small fibre functions are linked. Cutaneous perfusion and skin temperature at the foot have a strong relationship. Furthermore, skin temperature is an independent predictor of cutaneous perfusion. The results have clinical implications, as simple, non-invasive techniques can be significantly used to determine the

risk of the foot, as temperature changes have been associated with foot complications in previous studies (Gatt et al., 2018).

References

Gatt, A., Falzon, O., Cassar, K., Ellul, C., Camilleri, K. P., Gauci, J., Mizzi, S., Mizzi, A., Sturgeon, C., Camilleri, L., Chockalingam, N., & Formosa, C. (2018). Establishing Differences in Thermographic Patterns between the Various Complications in Diabetic Foot Disease. *International Journal of Endocrinology*, *2018*, 1–7. https://doi.org/10.1155/2018/9808295

Körei, A. E., Istenes, I., Papanas, N., & Kempler, P. (2016). Small-Fiber Neuropathy: A Diabetic Microvascular Complication of Special Clinical, Diagnostic, and Prognostic Importance. *Angiology*, *67*(1), 49–57. https://doi.org/10.1177/0003319715583595

Vas, Prashanth. R. J., Green, Alistair. Q., & Rayman, Gerry. (2012). Small fibre dysfunction, microvascular complications and glycaemic control in type 1 diabetes: a case–control study. *Diabetologia*, *55*(3), 795–800. https://doi.org/10.1007/s00125-011-2417-9

Veves, Aristidis., Giurini, J. M., & LoGerfo, F. W. (2006). *The diabetic foot*. Humana Press.