


MATTERS ARISING

Open Access



Is handheld video microscopy really the future of microcirculation monitoring?

Matthias Jacquet-Lagrèze^{1,2,3}, Mathieu Magnin^{4,5}, Bernard Allaouchiche^{2,5,6} and Stanislas Abrard^{2,7,8*} 

We have read with great interest the article by J. Duran-teau and colleagues entitled “The future of intensive care: the study of the microcirculation will help to guide our therapies” [1]. In their review, the authors emphasize the scientific rationale for handheld video microscopy (HVM). HVM is a technique used to visualize blood flow and microcirculation in real time. The authors have described numerous advantages associated with this method. To provide the reader with a comprehensive understanding of the technical and medical issues that limit the clinical use of this technique at the bedside, we propose to highlight ten common pitfalls and drawbacks of HVM:

1. Artifact interference: HVM can be prone to artifacts, including motion artifacts caused by patient

movement and pressure artifacts from the microscope probe. Pressure artifacts in particular are quite common and challenging, but some efforts have been made to mitigate them [2, 3]. The risk of misinterpretation of microcirculation due to pressure artifacts is of concern. These artifacts can mimic abnormal microcirculation patterns, leading to misinterpretation of the acquired images. In fact, we have observed a direct correlation between acceptable pressure artifacts and microcirculation analysis, as well as a strong association between pressure artifacts and mean arterial pressure [4].

2. Technical complexity: Performing sublingual video microscopy requires specialized equipment, technical expertise, and training. Analyzing the captured images and extracting meaningful data can be a complex task. Image stabilization and processing, vessel segmentation, and quantitative analysis methods may require expertise in image analysis. Analysis is a time-consuming process for an experienced operator. Automated analysis of HVM videos is reliable, but has not been validated in a prognostic assessment or interventional study. The analysis requires sufficient image quality, superior to that required by the human eye. Artifacts can lead to misinterpretation by the software and inaccurate diagnoses or conclusions. Alternatives to HVM exist: Photoplethysmography is a simpler technique that is already available in all centers and shows promising results for continuous monitoring of oxygenation and tissue perfusion [5, 6]. In contrast, HVM was able to provide continuous measurements in only 35% of patients within a short period of 3 minutes [7]. Integrated into a hemodynamic optimization protocol, tissue oxygenation monitoring varied in accordance with HVM [8, 9].

This comment refers to the article available online at <https://doi.org/10.1186/s13054-023-04474-x>.

*Correspondence:

Stanislas Abrard

stanislas.abrard@chu-lyon.fr

¹ Service d'Anesthésie-Réanimation, Hôpital Louis Pradel, Hospices Civils de Lyon, 59, Boulevard Pinel, 69677 Bron Cedex, France

² Faculté de Médecine Lyon Est, Université Claude Bernard Lyon 1, 8, Avenue Rockefeller, 69373 Lyon Cedex 08, France

³ Laboratoire CarMeN, Inserm UMR 1060, Université Claude Bernard, Lyon 1, Lyon, France

⁴ Unité de Physiologie, Pharmacodynamie et Thérapeutique, VetAgro Sup, Université de Lyon, 1 Avenue Bourgelat, 69280 Marcy L'Étoile, France

⁵ Pulmonary and Cardiovascular Aggression in Sepsis APCSe, UPSP 2021. A101, Université de Lyon, VetAgro Sup, Campus Vétérinaire de Lyon, 69280 Marcy L'Étoile, France

⁶ Centre Hospitalier Lyon-Sud, Service de Réanimation, Hospices Civils de Lyon, 69310 Pierre-Bénite, France

⁷ Service d'Anesthésie-Réanimation, Hospices Civils de Lyon, Hôpital Edouard Herriot, 5 Pl d'Arsonval, 69437 Lyon, France

⁸ Institut MitoVasc, INSERM 1083 - CNRS 6015, Université d'Angers, 3 Rue Roger Amsler, 49100 Angers, France



© The Author(s) 2023. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

3. Patient cooperation and invasive nature: Obtaining clear and accurate images with sublingual video microscopy requires the patient cooperation. Excessive tongue movement or discomfort may interfere with the acquisition of high-quality images. Although sublingual video microscopy is non-invasive compared to other imaging techniques such as intravital microscopy, it still requires the placement of a device under the tongue. Some patients may find this uncomfortable or invasive, which can affect the patient compliance.

4. Standardization and variability: Standardizing the technique and ensuring consistency across operators or studies can be challenging. Camera settings and image acquisition protocols can vary, leading to inconsistent results and limited comparability. HVM measurements showed significant intra- and inter-observer variability [10]. Baseline microcirculatory tissue perfusion variables also vary between individuals. This substantial inter-individual variability makes it difficult to interpret single measurements and to determine individual thresholds of damage. As with several other hemodynamic variables, operators use trends in repeated measurements to monitor the evolution of HVM parameters. In comparison, a single measure of endothelial reactivity appears to provide more prognostic [11] and therapeutic information [12, 13]. In these studies, endothelial reactivity was associated with preload dependence, response to volume expansion, and outcomes in cardiac surgery.

5. Limitations of accessible sites and depth: The technology used in HVM can only investigate tissues covered by a thin epithelial layer. Specifically, sublingual video microscopy focuses on examining the microcirculation beneath the tongue. While it provides valuable insight into the microvasculature in this region, it may not provide comprehensive information about the microvasculature in other parts of the body, except in intraoperative settings. However, if an important physiological property can be measured at one site (e.g., sublingual), this may represent a step forward compared to not having this insight at all.

6. Education and training: Successful implementation of sublingual video microscopy requires trained health-care professionals who can perform the technique, interpret the images, and integrate the findings into clinical decision-making. The availability of training programs and educational resources can influence the adoption and development of the technique.

7. Limited clinical utility: HVM cannot directly measure tissue oxygenation. It is an indirect measure that quantifies microcirculatory perfusion and convective and diffusive oxygen transport. Other technologies have the potential to enhance the information provided by HVM regarding tissue oxygenation. However, the integration

of probes for multimodal monitoring into a single device is currently unavailable. Although HVM provides valuable insights into the microcirculation, its clinical utility in guiding treatment decisions or improving patient outcomes is still under investigation. The translation of these imaging findings into actionable interventions or therapies is not yet well-established. In addition, simpler tools such as capillary refill time (CRT) have similar prognostic value [14]. CRT has the advantage of having been tested as a target in a multicenter interventional trial. It has shown promising results [11].

8. Lack of evidence: Demonstration of the clinical utility and effectiveness of a new technique is essential for its widespread adoption. The first randomized clinical trial of HVM did not confirm its benefit in terms of survival [15]. This study has several methodological weaknesses. The evaluation of microcirculation with an invalidated analysis method was used to guide resuscitation without linking with a clear treatment protocol. In addition, this practice was associated with an increase in the amount of fluids and vasopressors administered. Large, methodologically strong clinical trials demonstrating improved outcomes are needed to place sublingual video microscopy as a central component of patient care.

9. Cost and availability: Limited availability of sublingual video microscopy equipment and expertise can be a challenge in certain health-care settings or regions. The cost of the equipment and maintenance can also be a barrier to its widespread adoption. High-quality video microscopy, including the microscope, camera, lighting systems, and software, can be financially burdensome, particularly for some health-care facilities or research laboratories with limited resources.

10. Regulatory and reimbursement challenges: The introduction of any new medical technology involves navigating regulatory processes and securing reimbursement from health-care systems or insurance providers. These challenges can sometimes slow the adoption of new technologies, including sublingual video microscopy. Some technologies (laser Doppler and echocardiography) have the same drawback. However, it should be noted that other technologies already widely available or easily accessible are much less expensive (CRT and plethysmography). In these cases, lack of reimbursement is less of a problem.

In conclusion, HVM has significant scientific value as a tool in clinical research. However, it is important to note that HVM is not ready for routine clinical use. Manufacturers and investigators are working to improve devices, software, and clinical validation of HVM. In addition, alternative tools have emerged with interesting capabilities that are easier to use and already accessible in most centers. Therefore, while advancing HVM, it is crucial

to ensure that its development does not overshadow the importance of these existing technologies and their clinical evaluation.

Acknowledgements

None.

Author contributions

Study concept and design is not applicable. Acquisition of data is not applicable. Interpretation of data is not applicable. S.A., M.M, B.A, and MJL helped in drafting of manuscript. Statistical analysis is not applicable. Study supervision is not applicable. S.A., M.M, B.A, and MJL helped in critical revision of the manuscript for important intellectual content. S.A., M.M, B.A, and MJL helped in final approval of the version to be published. S.A., M.M, B.A, and MJL helped in agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Funding

This comment received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Availability of data and materials

Not applicable.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors have no conflicts of interest related to the study to declare.

Received: 7 September 2023 Accepted: 8 September 2023

Published online: 12 September 2023

References

- Duranteau J, De Backer D, Donadello K, Shapiro NI, Hutchings SD, Rovas A, et al. The future of intensive care: the study of the microcirculation will help to guide our therapies. *Crit Care*. 2023;27:190.
- Balestra GM, Bezemer R, Boerma EC, Yong Z-Y, Sjauw KD, Engstrom AE, et al. Improvement of sidestream dark field imaging with an image acquisition stabilizer. *BMC Med Imaging*. 2010;10:15.
- Ince C, Boerma EC, Cecconi M, De Backer D, Shapiro NI, Duranteau J, et al. Second consensus on the assessment of sublingual microcirculation in critically ill patients: results from a task force of the European Society of Intensive Care Medicine. *Intensive Care Med*. 2018;44:281–99.
- Magnin M, Foulon É, Lurier T, Allaouchiche B, Bonnet-Garin J-M, Junot S. Evaluation of microcirculation by Sidestream Dark Field imaging: Impact of hemodynamic status on the occurrence of pressure artifacts—a pilot study. *Microvasc Res*. 2020;131: 104025.
- Coutrot M, Joachim J, Dépret F, Millasseau S, Nougué H, Matéo J, et al. Noninvasive continuous detection of arterial hypotension during induction of anaesthesia using a photoplethysmographic signal: proof of concept. *Br J Anaesth*. 2019;122:605–12.
- Agerskov M, Thusholdt ANW, Holm-Sørensen H, Wiberg S, Meyhoff CS, Højlund J, et al. Association of the intraoperative peripheral perfusion index with postoperative morbidity and mortality in acute surgical patients: a retrospective observational multicentre cohort study. *Br J Anaesth*. 2021;127:396–404.
- Riedijk MA, Milstein DMJ. Imaging sublingual microcirculatory perfusion in pediatric patients receiving procedural sedation with propofol: a pilot study. *Microcirculation*. 2018;25: e12484.
- O'Neil MP, Alie R, Guo LR, Myers M-L, Murkin JM, Ellis CG. Microvascular responsiveness to pulsatile and nonpulsatile flow during cardiopulmonary bypass. *Ann Thorac Surg*. 2018;105:1745–53.
- Atasever B, Boer C, Speekenbrink R, Seyffert J, Goedhart P, de Mol B, et al. Cardiac displacement during off-pump coronary artery bypass grafting surgery: effect on sublingual microcirculation and cerebral oxygenation. *Interact Cardiovasc Thorac Surg*. 2011;13:573–7.
- Valerio L, Peters RJ, Zwinderman AH, Pinto-Sietsma S-J. Reproducibility of sublingual microcirculation parameters obtained from sidestream darkfield imaging. *PLoS ONE*. 2019;14:e0213175.
- Zampieri FG, Damiani LP, Bakker J, Ospina-Tascón GA, Castro R, Cavalcanti AB, et al. Effects of a resuscitation strategy targeting peripheral perfusion status versus serum lactate levels among patients with septic shock. A Bayesian reanalysis of the ANDROMEDA-SHOCK Trial. *Am J Respir Crit Care Med*. 2020;201:423–9.
- Abrard S, Fouquet O, Riou J, Rineau E, Abraham P, Sargentini C, et al. Preoperative endothelial dysfunction in cutaneous microcirculation is associated with postoperative organ injury after cardiac surgery using extracorporeal circulation: a prospective cohort study. *Ann Intensive Care*. 2021;11:4.
- Futier E, Christophe S, Robin E, Petit A, Pereira B, Desbordes J, et al. Use of near-infrared spectroscopy during a vascular occlusion test to assess the microcirculatory response during fluid challenge. *Crit Care*. 2011;15:R214.
- Huang W, Xiang H, Hu C, Wu T, Zhang D, Ma S, et al. Association of sublingual microcirculation parameters and capillary refill time in the early phase of ICU admission. *Crit Care Med*. 2023. <https://doi.org/10.1097/CCM.0000000000005851>.
- Bruno RR, Wollborn J, Fengler K, Flick M, Wunder C, Allgäuer S, et al. Direct assessment of microcirculation in shock: a randomized-controlled multicenter study. *Intensive Care Med*. 2023;49:645–55.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.