Published in final edited form as:
Plast Reconstr Surg. 2019 November ; 144(5): 933e–934e. doi:10.1097/PRS.0000000000006124.

The Role of Intraoperative Laser Speckle Imaging in Reducing Postoperative Complications in Breast Reconstruction

Alisha Bonaroti, MD, MS[1], **Ryan C. DeCoster, MD**[1,2], **Siavash Mazdeyasna, MS**[3], **Chong Huang, PhD**[3], **Guoqiang Yu, PhD**[3], **Lesley Wong, MD**[2]

[1]Division of Plastic Surgery, University of Kentucky, Lexington, KY.

[2]Lucille P. Markey Cancer Center, University of Kentucky, Lexington, KY.

[3]F. Joseph Halcomb III, M.D., Department of Biomedical Engineering, University of Kentucky, Lexington, KY.

Keywords

Breast reconstruction; noninvasive; laser speckle

We read with interest the article by To and colleagues on *Intraoperative Tissue Perfusion Management by Laser Speckle Imaging: A Potential Aid for Reducing Postoperative Complications in Free Flap Breast Reconstruction*.[1] The current standard for assessing skin flap viability is clinical judgement. Invasive technologies such as laser-assisted indocyanine green (ICG) angiography have been employed, however, they are associated with high costs, possible anaphylaxis, and non-continuous imaging.[2] LSCI has emerged over the past decade as a method for real-time imaging of perfusion dynamics based on moving red blood cells which cause scattering of coherent laser light. Spatial and temporal fluctuations in laser speckle patterning allow for 2D mapping of tissue perfusion. However, a significant limitation of LSCI is the shallow penetration depth (~1 mm).

Our laboratory has recently introduced a novel speckle contrast diffuse correlation tomography (scDCT) device which overcomes the depth limitation of LSCI. The scDCT uses a galvo mirror to remotely deliver focused near-infrared point light to source positions and employs a sensitive sCMOS camera (scientific complementary metal-oxide-semiconductor) to rapidly quantify diffuse spatial speckle fluctuations. Since point illumination produces high photon density for deep tissue penetration, scDCT enables noncontact 3D imaging of blood flow distributions in relatively deep tissues (~10 mm). This system also integrates an innovative photometric stereo technique with the same camera to obtain tissue surface geometry. The scDCT has been tested in tissue-simulating phantoms, rodent brains, human burns, wounds, and mastectomy skin flaps. In a preliminary study

---

Corresponding Author: Dr. Alisha Bonaroti, Division of Plastic and Reconstructive Surgery, University of Kentucky College of Medicine, 740 South Limestone St., Lexington, KY 40536, USA, Telephone Number: 859-323-6328, Fax Number: 859-257-7150, abonaroti@uky.edu.

Disclosures: The authors have no associations or financial disclosures to report that create a conflict of interest with the information presented in this article.

using scDCT and commercially available ICG angiography, we observed similar perfusion patterns on mastectomy skin flap surfaces. Interestingly, lateral and depth heterogeneities in blood flow distribution were captured by our scDCT, suggesting the value of imaging the entire mastectomy skin flap volume. In addition, we also obtain 3D maps of tissue blood flow distributions. Compared to 2D mapping, 3D imaging quantifies blood flow distributions more accurately. We are currently testing scDCT in patients with the expectation that perioperative monitoring of ischemic tissues and their recoveries in mastectomy skin flaps will provide objective information for the assessment and management of skin flap viability to prevent skin flap necrosis and other complications. Since postoperative mastectomy skin flap thickness is approximately 10 mm, imaging techniques with depth capabilities and 3D analysis may be more beneficial than LSCI.[3–5]

In conjunction with the findings of To et al, these studies collectively suggest that noninvasive detection of light scattering is a promising technology that may be used to identify tissue with regional ischemia for varying reconstructive approaches. To et al are to be commended for their use of LSCI to assess the intraoperative feasibility of this technology. Future work should determine the role of intraoperative non-invasive, non-contact methodologies to accurately predict tissue viability in both prosthetic and autologous breast reconstruction. Identification of compromised tissue intraoperatively may augment surgical decision making and allow for revisions prior to leaving the operating room.

Acknowledgments:

Funding Sources: Drs. Wong and Yu are current recipients of a National Endowment for Plastic Surgery grant (3048112770) from the Plastic Surgery Foundation (PSF) grant for non-invasive mastectomy-flap monitoring in breast reconstruction. Dr. DeCoster is supported by a National Cancer Institute training grant (T32CA160003). The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH or PSF.

References:

1. To C, Rees-Lee JE, Gush RJ, et al. Intraoperative Tissue Perfusion Measurement by Laser Speckle Imaging: A Potential Aid for Reducing Postoperative Complications in Free Flap Breast Reconstruction. Plast Reconstr Surg 2019;143(2):287e–292e.
2. Kanuri A, Liu AS, Guo L. Whom should we SPY? A cost analysis of laser-assisted indocyanine green angiography in prevention of mastectomy skin flap necrosis during prosthesis-based breast reconstruction. Plast Reconstr Surg 2014;133(4):448e–454e.
3. Agochukwu NB, Huang C, Zhao M, et al. A Novel Noncontact Diffuse Correlation Spectroscopy Device for Assessing Blood Flow in Mastectomy Skin Flaps: A Prospective Study in Patients Undergoing Prosthesis-Based Reconstruction. Plast Reconstr Surg 2017;140(1):26–31. [PubMed: 28654584]
4. Huang C, Irwin D, Zhao M, et al. Noncontact 3-D Speckle Contrast Diffuse Correlation Tomography of Tissue Blood Flow Distribution. IEEE Trans Med Imaging 2017;36(10):2068–2076. [PubMed: 28574345]
5. Mazdeyasna S, Huang C, Zhao M, et al. Noncontact speckle contrast diffuse correlation tomography of blood flow distributions in tissues with arbitrary geometries. J Biomed Opt 2018;23(9):1–9.