The Great River Wound and Hyperbaric Medicine Clinic in West Burlington, Iowa provides comprehensive wound care services to the southeast Iowa area, which includes adjacent portions of western Illinois and northeast Missouri. One of the ways the clinic excels in the delivery of patient care is by incorporating the latest technologies into assessment and treatment of complex chronic and acute wounds. The recent addition of the LUNA™ Fluorescence Microangiography System (NOVADAQ® Technologies, Mississauga, Ontario) has improved the clinic’s ability to provide timely assessment of wound area perfusion, including detailed assessment of flap and graft viability and validation of advanced treatment modalities such as hyperbaric oxygen therapy.
Figure 1. Initial still image shows fibrin at the base of the wound. Other findings are consistent with chronic wound, including epibolized and undermined wound edges.

Figure 2. Initial LUNA fluorescence microangiography study showed intense wound edge reaction, but with limited fluorescence at the muscle and bone levels of the wound.

Figure 3. Follow-up still image of the patient in the case report shows gradually improving granulation tissue.

Figure 4. Follow-up LUNA fluorescence microangiography study shows increased fluorescence of deep tissue layers.
The LUNA system utilizes four key components in obtaining real-time high-definition images of tissue perfusion:
1. Imaging agent indocyanine green (ICG)
2. Near-infrared laser
3. Charge-coupled device camera
4. Computer with highly sophisticated image acquisition and processing software

ICG was approved by the Food and Drug Administration (FDA) in 1959, and established an impressive safety record in over 50 years of clinical use. ICG is metabolized by the liver and is therefore safe to use in patients with renal function impairment. ICG should be used with caution in patients with known sensitivity to iodine.

ICG-guided fluorescence angiography has established clinical and economic value through outcomes-based studies in open cardiovascular, plastic and reconstructive, transplant, and gastrointestinal surgeries. One of the keys to successful completion of these complex procedures is real-time assessment of tissue perfusion. Similarly, because regional perfusion is a problem in chronic and acute wounds, fluorescence angiography's ability to demonstrate small-vessel blood flow has facilitated its natural migration to the outpatient wound care setting.

Generally, LUNA studies are performed on a dedicated half-day. The physician performs fluorescence microangiography only after a thorough patient history and physical examination. LUNA provides complementary information to initial vascular screening studies, including laser Doppler toe pressure and transcutaneous oxygen monitoring (TCOM). In many cases, LUNA serves as the primary method of vascular assessment due to inherent limitations of established technologies, such as effective lead placement.

The procedure is straightforward and well tolerated by patients. When the patient arrives at the clinic, he or she is escorted to a treatment room where informed consent is obtained. The nursing staff obtains intravenous (IV) access and the patient’s information is entered into the LUNA system. LUNA prompts the user for relevant information and data entry is intuitive and efficient. The patient is then positioned for optimal image acquisition. Care is taken to minimize background lighting. It is also important to position the imaging head so there are no areas of exposed skin other than the area of interest. A still color wound image is obtained using the LUNA snapshot feature. The patient is intravenously injected with 2.5-3.0 mL of ICG (2.5 mg/mL), followed by a 10 mL saline flush. Of note, any problems with IV access are easily overcome with a peripherally inserted central catheter (PICC) or central line, which are frequently used for IV antibiotic therapy related to wound infection.

Figure 5. SPYQ region analysis tool was used to select muscle tissue at the base of the wound for serial comparison. The resulting calculations show significant improvement in the ingress and egress parameters. The top graph and image show the initial findings, while the bottom graph and image show the improvements noted at follow-up 6 weeks later.
After injection, ICG is rapidly bound by plasma protein and distributed throughout the intravascular space. As ICG arrives at the wound area within 3-5 mm of the skin surface, the molecule is excited by near-infrared light emitted from a source in the imaging head of the LUNA system. The resulting fluorescence is captured by the camera and recording software. Given that ICG is transported to the wound area by the arterial system and taken from the wound area by the venous system, LUNA offers a detailed analysis of blood flow to the wound area (ingress) as well as blood flow away from the wound area (egress). Through evaluation of these two phases, a complete picture of tissue perfusion is established.

The information recorded by the LUNA system is subsequently analyzed using powerful SPYQ objective image analysis and comparison software. The SPYQ analysis tool kit facilitates a detailed assessment of the wound area perfusion by application of contrast and assignment of relative signal intensities. There is also a regional analysis tool, which allows the user to select an area of interest within the wound for more detailed evaluation. A report is compiled documenting key images, ingress, and egress. The report can be forwarded to the referring physician and placed in the patient’s chart. The preliminary results and follow-up plans are discussed with the patient and the IV is discontinued.

Case Study

A 77-year-old Caucasian female patient with a remote history of breast cancer post-radiation therapy underwent a median sternotomy for aortic valve replacement. The procedure was abandoned due to hostile mediastinum. The postoperative course was mostly uneventful with the exception of a wound area abscess, for which the patient underwent incision and drainage. The patient was subsequently referred to the wound clinic for evaluation and treatment.

The wound was initially debrided and a specimen of bone from the base of the wound demonstrated findings consistent with chronic osteomyelitis. Intravenous antibiotics were initiated based on culture findings and we continued negative pressure wound therapy. The patient was offered adjunctive hyperbaric oxygen therapy. Following six weeks of therapy, repeat ICG-guided fluorescence vascular microangiography was ordered.

LUNA’s image analysis software showed definite improvement in wound area perfusion, including improved granulation tissue quality. Furthermore, the LUNA images helped to define areas of the wound that required further debridement and topical care.

SPYQ software was utilized to quantify noted improvements and the resulting report was forwarded to the referring and primary care providers. The visual information was also used to target non-viable wound areas for debridement.

Presently*, the patient’s wound continues to improve with only topical care following completion of hyperbaric oxygen and IV antibiotic therapy. Of note, she was offered a plastic and reconstructive surgery consultation, but declined. The LUNA Fluorescence Microangiography System assisted with difficult medical decision-making, utilization review, and validation of noted treatments for this patient.

Conclusion

In summary, the LUNA Fluorescence Microangiography System improves several facets of wound care delivery based on the ability to visualize real-time tissue perfusion. Moreover, patients are able to observe the study and the images as they are recorded. They are made aware of preliminary findings immediately. As a result, patients have reported that they feel more integrated into the wound care process, a sentiment that drives referrals as well as positive satisfaction ratings.

*As of May 15, 2014.

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References