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Device Measures Tissue Oxygenation at Wound Site; May Predict Difficult-to-Heal Diabetic Foot Ulcers

By Joene Hendry

A diagnostic device may help predict potentially non-healing foot ulcers by providing non-invasive measurements of tissue oxygenation at the wound site, German researchers report.

Stefan Beckert, MD, and his colleagues in the Department of General Surgery at the University of Tübingen in Germany used the micro-lightguide spectrophotometer O2C (Oxygen to See) to assess tissue oxygenation and microvascular blood flow on intact forefoot skin and plantar surface ulcers in 14 patients with diabetes. The patients, aged from 21 to 52 years, participated in the study while receiving treatment at the university's ambulatory wound clinic.

The O2C uses laser Doppler and spectrometric techniques to measure relative blood flow, flow velocity, hemoglobin concentration, and hemoglobin oxygenation through a glass fibre probe placed on the skin. Manufactured by LEA Medizintechnik (www.lea.de), in Geissen, the device is commonly used in Germany to assess oxygen supply in and around diabetic foot ulcers, reports the company's managing director Alfons Krug.

“In Germany we do not have general podiatrists,” Beckert told Podiatry Online, adding that, “Treatment and vascular assessment of diabetic foot ulcers is performed mainly by surgeons and diabetologists.”

Blood Flow Higher in Healers

Beckert's group first measured the forefoot skin of 20 healthy volunteers on two consecutive days. They used these measurements to establish the reliability and reproducibility of O2C measurements.

When they compared these readings with those of the group of patients with diabetes, they found no significant differences in readings from 2mm below the skin surface.

In readings from a depth of 6 mm, the patients with diabetes showed significantly higher relative blood flow than control patients, and when Beckert's team compared readings from the group of eight patients with ulcers that did not heal with those from the six patients who healed, their data revealed significant differences in O2C readings. Yet the healers and non-healers showed no significant differences in initial wound size, age, neuropathy score or transcutaneous oxygen tension.

Measurements of intact forefoot skin at the 2 mm depth showed non-healers with significantly lower hemoglobin oxygenation than healers and healthy controls. At the 6 mm depth, healers had significantly higher relative blood flow while non-healers had significantly lower relative blood flow compared with healthy controls.

Measurements taken at the wound sites revealed that healers had significantly higher values in all parameters, at both the 2 mm and 6 mm depths, than non-healers. In values of relative blood flow,

the patients with ulcers that healed had approximately 10 times higher flow at the 2 mm depth and about 4 times higher flow at the 6 mm depth than did patients with non-healing ulcers.

Application in Diabetes Patients

O2C measurements are easy to perform and accurate, but the investigators noted the importance of comparing measurements at the wound site with those on intact forefoot skin to help identify potentially non-healing wounds. Their data suggests that hemoglobin oxygenation of less than 30% at a 2 mm depth on intact skin at the forefoot and a relative blood flow reading less than 30 arbitrary units at a 6 mm depth indicates severely impaired healing.

“The O2C micro-lightguide spectrophotometer is a new promising tool for the quantitative assessment of tissue microperfusion,” Beckert and colleagues write in the December 2004 issue of *Diabetes Care* (Vol. 27, No. 12). In patients with diabetic foot ulcers, measurements taken directly at the wound site, they add, “makes it possible to predict the severity of ischemia and chances for healing and to select the appropriate treatment.”

The O2C device costs \$39,000 Euro for the device and \$1,950 Euro for the probe, which is about \$55,000 US, and is available in numerous variations to accommodate its uses, which include assessment of oxygen supply to tissues during surgery and to organs during transplantation procedures. But with limited distribution in the United States, Krug said that he is not aware of any US-based studies or applications of the O2C device for diabetic foot ulcers.