**SUPPLEMENTARY MATERIAL**

**Supplementary Note 1:**

**RSOM system**

Tissue excitation and optoacoustic signal generation were achieved using a pulsed laser (Wedge HB.532, Bright Solutions, Pavia, Italy) running at 532 nm with 0.9 ns pulse width. The repetition rate of the laser could be adjusted from a single shot up to 2 kHz with maximum output energy of 1 mJ per pulse. Laser light was delivered to the surface of the skin via a custom-made fiber bundle (CeramOptec, Riga,, Latvia) with one input arm and two output arms. Output light energy delivered to the skin surface never exceeded 3.75 µJ/mm2 at a 500 Hz repetition rate, in order to comply with ANSI laser exposure safety limits 1.

The broadband optoacoustic signal was received by a customized, spherically focused piezoelectric transducer with 10-120 MHz bandwidth and 50 MHz central frequency (Sonaxis, Besancon, France). The transducer has a 3 mm focal distance and an active element with 3 mm diameter. The broad bandwidth of the transducer allows resolution of the microvasculature of the horizontal plexus as well as small arterioles and venules at the epidermal-dermal junction. The detected optoacoustic signal was amplified using a low-noise amplifier (63 dB; AU-1291, MITEQ, Hauppauge, New York, USA). Analog signals were digitized using a high-speed digitizer (EON-121-G20; Gage Applied Technologies, Montreal, Canada) working at a sampling rate of 1 GS/s. Data were acquired by raster-scanning the detector and two outputs of the fiber bundle on precise piezoelectric stages (Physik Instrumente, Auburn, the USA). Data were collected from a region of interest (ROI) measuring 4 mm × 2 mm in steps of 15 µm.

The fiber bundle outputs, transducer, and moving stages were enclosed in a compact 3D-printed scanning head made of polylactic acid material. A small compartment (interface unit) filled with water as coupling medium was placed at the bottom of the scanning head. The coupling medium allowed the generated optoacoustic waves to travel from the skin surface to the transducer without major energy losses. The interface unit was affixed to the forearm using double-sided tape.

**Supplementary Note 2:**

**Image reconstruction and representation**

The two frequency bands were reconstructed separately, and frequency band equalization was performed 2 Reconstruction parameters were adjusted by assuming a constant speed of sound in the reconstructed volume. To avoid instability of measurements caused by temperature variation in the coupling medium, speed of sound was defined to be the same as the published speed of sound in water at the nominal temperature set in the temperature control system (e.g. 1525 m/s at 25 °C, 1585 m/s at 44 °C).

**REFERENCES**

1. Lasers Institute of America. *American National Standard for Safe Use of Lasers*.; 2007.

2. Aguirre J, Schwarz M, Garzorz N, et al. Precision assessment of label-free psoriasis biomarkers with ultra-broadband optoacoustic mesoscopy. *Nat Biomed Eng*. 2017;(in press):1-13. doi:10.1038/s41551-017-0068.