Infrared thermal modulation endoscopy for label-free tumor detection

For the characterization of the ITME, a USAF 1951 resolution test target (R3L2S1P, Thorlabs, NJ, USA) attached to a heating pad (SRFR-3/5-P, Omega Engineering Inc., United Kingdom) was imaged with and without the insertion scope. With the insertion scope in place, ITME achieved a circular imaging field with a diameter of 5.28 mm, while a diameter of 6.93 mm was achieved without the insertion scope (Fig. S1a). In addition, a heating plate (LCI-0016 controlled by CU-201, Live Cell Instrument, South Korea) was imaged to assess the uniformity of the presented system (Fig. S1b). The cross sectional temperature profiles from X and Y-axes were plotted to evaluate the uniformity as shown in Fig. S1c.

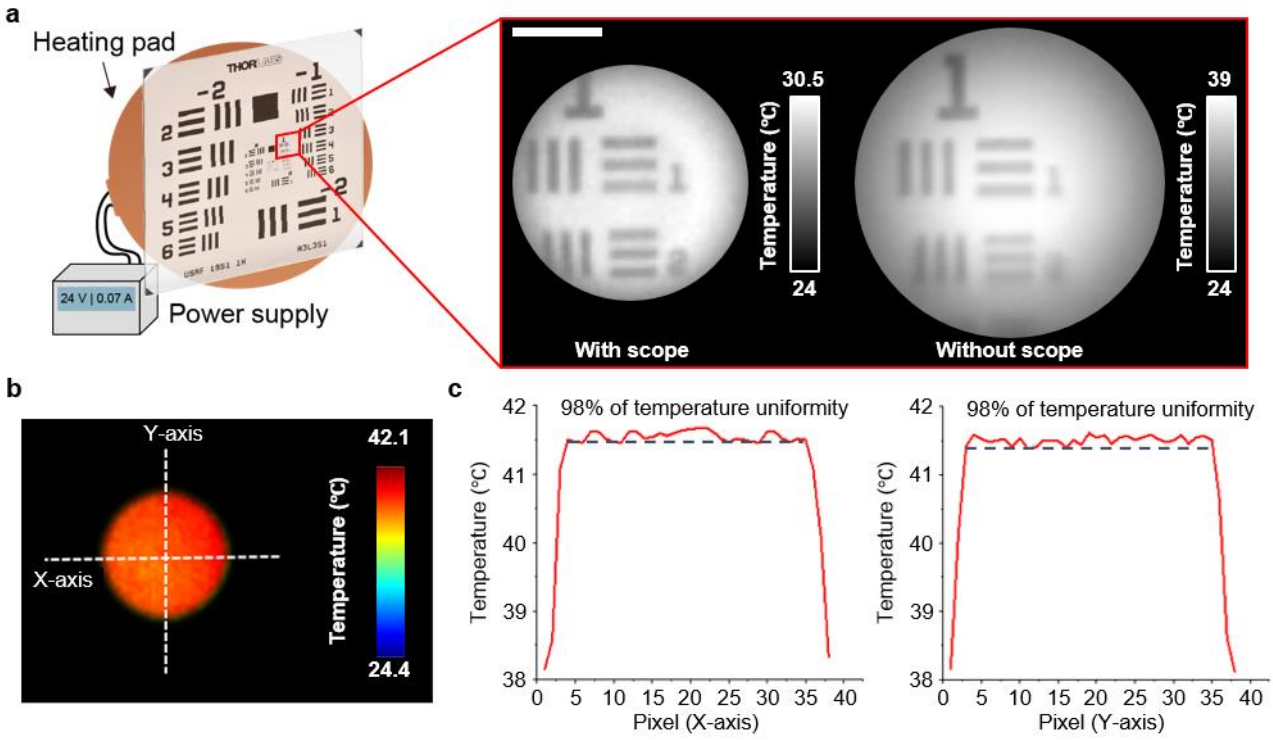

Fig. S1. Characterization of thermal endoscopy system. (a) Thermal imaging with and without the insertion scope using a USAF 1951 target attached to a heating pad. Scale bar: 2 mm. (b) The IR image demonstrating flat-top temperature distribution of the heating plate taken with the ITME. (c) Cross-sectional intensity profiles along the X and Y-axes derived from (b), indicating 98% temperature uniformity.

To compare the temperature changes in the presence and absence of blood flow, tumor-containing tissue was excised from a subcutaneous tumor mouse model, and the same active thermal modulation measurement was performed (Fig. S2a). The steady-state temperatures of both the tumor and neighboring tissues were lower than those in the subcutaneous model, attributed to the absence of blood supply. During convective heating, the rate of temperature change in tumor tissue was higher, with a less pronounced difference compared to that in the intact subcutaneous model. Furthermore, after the heating modulation, the temperatures of the tissues did not revert to their pre-modulation levels.

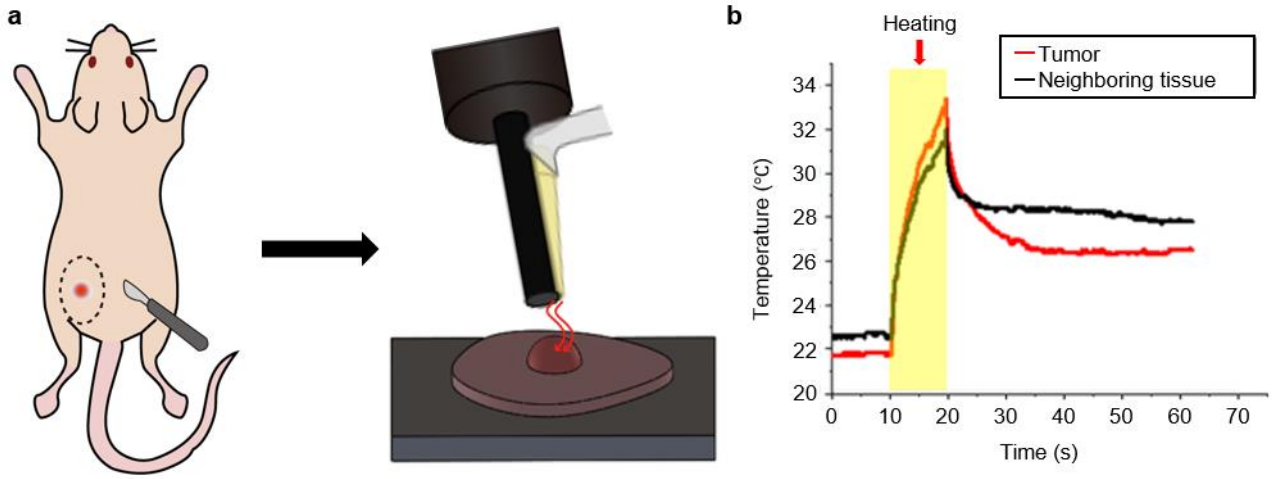

Fig. S2. Active thermal imaging of excised *ex vivo* tissue containing tumor. (a) Tissue excised from the vicinity of the tumor in a subcutaneous tumor mouse model was subjected to thermal imaging using the endoscopic system. (b) Temporal temperature changes in the tumor and neighboring tissue during convectional heating are presented.