Non-invasive melanoma thickness measurement

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Technology description

PAGE SUMMARY

Melanoma is a malignant tumor of melanocytes, which are melanin-producing cells located predominately in the skin. Melanoma is one of the most aggressive and deadly types of cancer. Approximately 80,000 new cases of invasive melanoma are diagnosed in the United States, and about 10,000 people die of the disease annually. Melanoma treatments are most effective in the early stages; however, there is no easy way to detect melanoma other than an invasive biopsy. To address this problem, Drexel’s biomedical engineers have created a portable non-invasive device for accurately measuring melanoma thickness right in a physician’s office.

Melanoma occurs when melanocytes in the epidermis grow out of control. The earliest stage of melanoma grows radially within the epidermis, and becomes increasingly lethal as it advances deeper into the skin. Melanoma thickness, or Breslow Thickness (BT), is the most important histopathological factor for its staging and is closely related to survival rate. The five-year survival rate is 95% if the tumor thickness is less than 1mm and only 50% when the tumor thickness is greater than 4 mm. Melanoma thickness is commonly measured by removing a portion of the lesion by shave or punch biopsy and histologically examining the sample. This method, when completed by experienced dermatologists, has been shown to underestimate the BT from 12% to 20% of the time. Complete excision of the lesion is the most accurate method of measuring BT, but this is often impossible due to the lesion covering too large a surface area or being in an aesthetically sensitive location. Moreover, 80% of malpractice claims relating to melanoma cite incomplete biopsy specimens as a contributing factor in disease progression.

Another issue is that the parameters for excision depth and surgical margins are highly inconsistent among dermatologists in terms of completely eliminating the lesion. For example, if melanoma thickness is < 1 mm (< 2 mm) then an area of 1 cm (2 cm) is removed laterally. As a result, a tedious and time-consuming process called Mohs surgery is commonly used to determine if the entirety of a malignant lesion has been removed. During this procedure, a surgeon serially removes and histologically examines sections of the lesion until the margins are clear of malignant cells. A tool that can conclusively and non-invasively measure the thickness of skin lesions in vivo would be invaluable for improving the accuracy of melanoma staging, and for determining the margins for surgical removal before the operation.

Drexel’ s melanoma thickness detector based on piezoelectric fingers (PEF) can non-invasively measure tumor thickness by contrasting the elastic modulus of a tumor from its surrounding tissues. A proprietary array of PEF sensors of varying geometries operating based on this principle can generate a 3D melanoma thickness map that can be used for diagnostic and surgery planning purposes. The advantages of PEF is that it can measure melanoma thickness of all ranges from less than 1 mm to larger than 4 mm non invasively and accurately. This makes it ideal as a tool to help dermatologist to determine melanoma thickness preoperatively and at a low cost.
High-frequency ultrasound (US), optical coherence tomography (OCT), and pulsed photothermal radiometry (PPRT) have been investigated for non-invasive evaluation of melanoma thickness. However, their usefulness is very limited as none of them can measure thickness larger than 2 mm. High-frequency US 10-100 MHz has been most investigated for this purpose, and has been shown to be useful only for melanomas less than 2 mm thick. US also tends to overestimate melanoma thickness. OCT has high resolution (about 15 microns) but cannot see deep within the epidermis, and is limited to shallow thicknesses of less than 1 mm. Similarly, in phantom studies PPRT has been shown to exhibit axial resolutions of about 100 microns and thickness capability of <2mm. Although these methods may be useful for preoperatively measuring early-stage melanoma thicknesses of less than 2 mm, there is no current means of accurately determining melanoma thickness larger than 2 mm non-invasively and inexpensively. Thicker melanomas require additional axial shavings and more serial section removals in Mohs surgery to achieve a clean margin, which is tedious and time-consuming not to mention the pain, the wait, and the agony that a patient must endure. Drexel’ s device overcomes these problems by measuring melanoma thickness in a very wide range non-invasively and nearly instantaneously.

Application area

Accurate measurements of melanoma thickness
Diagnosis and staging of melanoma
Accelerating Mohs surger
Rapid screening of suspect skin lesions

Advantages

Non-invasive, point of care melanoma detection and staging
Reduced number of iterations in Mohs surgery

Institution

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