The objective of the project

The main research aim of the proposed project is to determine the tissue structure of human epidermis, both normal and pathologically changed, and to identify changes in epidermal morphometry caused by selected melanocytic skin conditions (nevi and melanomas).

Although the structure of normal epidermis is in broad outline well defined, there exist significant variabilities in histopathological image of epidermal pathologies in melanocytic lesions. In the course of the project we will assess the usefulness of information on epidermal morphometry for the process of its automatic segmentation in images from histopathological examination.

Pathologists, based on their clinical experience, suggested associations between certain changes in epidermal structure and certain types of lesions. In this context, the aim of our project will be to verify whether such associations indeed exist, how strong are they, and whether it is possible to propose an effective diagnostic scheme for skin melanocytic lesions based solely on criteria related to epidermal morphometry.

The description of research to be carried out

In our project we will analyze digital histopathological whole slide images of skin sections stained with hematoxylin and eosin (the images will be taken under high magnification). The first part of our study will be focused on working out a method for epidermis segmentation (Fig. 1), which will correctly detect its boundary even if numerous nevi cells and melanocytes in dermis or nests of nevi cells are present.

Then we will work out a method for measuring epidermal morphometry: a) uniformity and symmetry of hyperplastic and atrophic sections of epidermis along its main axis, and b) distribution, elongation and degree of distortion of each individual rete ridge. In our method we will use graph methods, as main axes of epidermal "basis" and of individual retes form a planar graph (nodes correspond to points where retes are attached to the "basis", whereas edges – to individual segments of both the "basis" and retes). The proposed representation will allow to quantify and qualify the epidermal structure with respect to the number of retes, branches within individual retes, and bridging between adjacent retes, as well as to the thickness of individual segments (based on measurements of cross-sections perpendicular to the main axis of the given segment). Finally, we will assess the possibilities of making use of the obtained information to improve diagnostic process for common types of melanocytic lesions, in particular to detect melanomas in their early stage more effectively (Fig. 2).

The second part will consist in performing a statistical analysis of the obtained data by applying methods of machine learning in order to find how well both individual indexes and groups of indexes can discriminate between basic classes of melanocytic lesions: nevi, dysplastic nevi, and melanomas.

Reasons for choosing the research topic

Physicians consider the histopathological examination the gold standard in skin melanocytic lesions diagnosis. Nonetheless, it still has its serious drawbacks resulting in 20–25% cases of melanoma being misdiagnosed as benign lesions. One of the main reasons for such a high misdiagnosis rate is a subjective evaluation by pathologists, resulting from a vague definition of many routinely used histopathological criteria (particularly connected with epidermal morphometry) for melanocytic lesions – so far the diagnostic accuracy of most of these criteria has not been studied thoroughly.

The worked out algorithms (for epidermis segmentation and measuring its morphometry) will not only permit to determine the tissue structure of epidemis, but also to assess statistically the correctness and usefulness of the aforementioned morphometry-based criteria The proposed approach, based on fully-automated methods for segmentation and morphometric analysis of epidermis, will allow to analyze a large image dataset. Since that dataset will be carefully selected (it will consist of images of all most commonly diagnosed types of melanocytic lesions) and sufficiently large, it will be possible not only to verify the currently used criteria, but also to propose new, more effective diagnostic criteria. Additionally, out method for segmentation of epidermis will permit to develop other methods which will support the diagnostic process of melanocytic lesions, eg. the ones analyzing distribution patterns of melanocytes in epidermis (an important criterion in melanoma diagnosis).

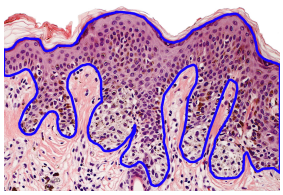

Figure 1. Histopathological image of a skin melanocytic lesion with boundaries of epidermis marked blue.

(a) Melanoma *in situ* (a malignant lesion) (b) Junctional dysplastic nevus (a benign lesion)

Figure 2. A comparison epidermal structures in different classes of lesions: (a) a melanoma, (b) a nevus.