

Abstract (streszczenie w języku angielskim)

Lichen planopilaris (LPP) is a chronic lymphocytic skin disease manifested by progressive scarring alopecia. The diagnosis of LPP is made based on histopathological examination, although it is not always definite. The current study evaluates the effectiveness of non-invasive atomic force microscopy (AFM) hair examination in detecting morphological differences between healthy and diseased hair.

The first paper summarizes the technical issues and operating basics of AFM. It also provides a review of previous studies using AFM in medical sciences, including hair research. Thanks to the possibilities offered by AFM imaging, the condition of hair and its possible disorders can be noninvasively assessed. In terms of hair research, the physicochemical and tribological properties of hair fibers, cells, and surface changes were studied. The research has been mainly concentrated on the effect of conditioners, hair-damaging external factors, and ethnic differences. The latest AFM studies of hair utilized hybrid techniques. Among other things, spectroscopic techniques are being used in conjunction with AFM. Fellows et al. used AFM integrated with an infrared spectroscopy (AFM-IR) to study the chemical composition of the cuticle, medulla, and cortex of European hair. In 2012, Shin et al. evaluated the morphology of the hair surface in patients with psoriasis vulgaris. They observed pits, increased roughness, and increased thickness of hair scales in patients with psoriasis.

Therefore, here it was decided to assess the hair surface of LPP patients and compare them with a control group. The first study was aimed at investigating and assessing the surface of healthy, virgin Caucasian hair by AFM. In this study, three to five hairs were collected from each person. Each hair was examined at nine locations (0.5; 1.0; 1.5; 2.0; 3.5; 4.5; 5.5; 6.5 and 7.0 cm from the root). At least 4 images (4–10 images) were taken at each of the 9 locations. A total of 496 photos were taken and analyzed. Metric measurements of hair scales, such as apparent length, width and scale step height, were taken. This publication presents the changes occurring in hair during the natural delamination process. In addition, morphological changes visualized on the surface of healthy hair (pitting, oval indentations, rod-shaped macro-fibrillar elements, globules, scratches, wavy edge) are presented. A quantitative analysis of the structures found was carried out. The findings of this study can be used in further research and work related to the subject of human hair. They can serve as a reference for research on scalp and hair diseases, as well as hair care.

The second study evaluated the structure and morphology of the hair surface of patients

with lichen planus (LPP) by atomic force microscopy. Here, three to five hairs from lesional skin of 10 LPP patients were collected and examined at nine locations using AFM. At least four images were taken at each of the nine sites. Metric measurements were taken and metric (length, width, and scale step height) and morphological features (striated and smooth surface of scales, the presence of endocuticle and cortex, shape of scales edges, scratches, pitting, cracks, globules, and wavy edge) were compared with hair from healthy controls. In addition, areas on diseased hair where the process of pathological, unnatural delamination of the hair fiber occurs are described. There was a statistically significant difference in the number of scratches in the initial sections of the LPP hair, in the intensity of wavy edges along the entire length of the tested hair, and in the number of scales with pitting in the middle section of the hair. In addition, a statistically significant fewer number of scales with striated surface was found in LPP group starting at 3.5 cm from the root continuing towards the free end of the hair.

This is to our knowledge the first comparison study about hair shaft surfaces over the whole lengths between LPP and healthy group using AFM. The study presented here made it possible to assess the dynamics of hair surface changes with distance from the root. The results presented in this study attempt to characterize morphological changes at the nanoscale, which may be helpful for early diagnosis of hair diseases in the future. The preliminary results provided give direction for further research into scalp and hair diseases. The hair of people with LPP and healthy hair have noticeable differences in their surface area. The etiology of the structures shown remains to be further discussed. Due to the time-consuming nature of the method and the need to take multiple measurements along the length of a single hair, a small group of individuals was included in the study. Of value for the above publication is the fact that similar morphological features have already been observed in previous, though few, publications. The pathogenesis of previously tested diseases is similar to LPP, so previous results confirm part of our observations. Therefore, further research in this direction seems reasonable.