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Fractal Dimension of Anal Intraepithelial Neoplasia (AIN)

AIN is a precancerous condition that is interrelated to infections by human papillomaviruses (HPV) and HIV. The histological classification of AIN is getting more and more important, due to increasing HPV infection rates throughout human population. Distinct grades of neoplasia are known, whereas high grades indicate a high risk for a tumor progression. Nevertheless, the grading diagnosis of histological slides is not always clear because of varying subjective conditions. In addition to subjective diagnoses, quantitative classification methods would be attractive but sophisticated solutions have not quantitatively been developed so far. Therefore, this study intends to evaluate digital images of AIN tissues by incorporating nonlinear morphological analysis. AIN tissues were H&E stained and digitally photographed with a standard microscope. Three distinct grades were diagnosed by a well trained pathologist in order to get a reference. The fractal dimensions of the images grey value landscapes using Fourier transformation were calculated and compared to the subjective diagnoses. Distinct grades of AIN led to distinct and well separated values of the fractal dimension. Higher grades of AIN yielded higher values of the fractal dimension. The conclusion is that fractal geometry is well suited for the diagnosis of AIN. The fractal dimension reflects the roughness of the images grey value distribution and is in accordance with the grading. Therefore, the fractal dimension is a quantitative value that may routinely support subjective diagnoses.

Keywords: intraepithelial neoplasia, image processing, fractal dimension, Fourier transformation