Objective grading of prostate carcinoma based on fractal dimensions: Gleason 3 + 4 = 7a ≠ Gleason 4 + 3 = 7b.

[Article in German]

Abstract

BACKGROUND: Significant intra- and interobserver variability ranging between 40 and 80% is observed in tumor grading of prostate carcinoma. By combining geometric and statistical methods, an objective system of grading can be designed.

MATERIAL AND METHODS: The distributions of cell nuclei in two-dimensional patterns of prostate cancer classified subjectively as Gleason score 3+3, 3+4, 4+3, 4+4, 4+5, 5+4, and 5+5 were analyzed with algorithms measuring the global fractal dimensions of the Rényi family and with the algorithm for the local connected fractal dimension (LCFD).

RESULTS: The dimensions for global fractal capacity, information, and correlation (standard deviation) were 1.470 (0.45), 1.528 (0.46), and 1.582 (0.99) for homogenous Gleason grade 3 (n = 16), 1.642 (0.34), 1.678 (0.41), and 1.673 (0.84) for homogenous Gleason grade 4 (n=18), and 1.797 (0.42), 1.791 (0.26), and 1.854 (0.31) for homogenous Gleason grade 5 (n=12), respectively. The LCFD algorithm can be used to distinguish both qualitatively and quantitatively between mixed and heterogeneous patterns, such as Gleason score 3+4=7a (intermediate risk cancer) and Gleason score 4+3=7b (high-risk cancer). Sensitivity of the method is 89.3%, and specificity 84.3%.

CONCLUSION: The method of fractal geometry enables both an objective and quantitative grading of prostate cancer.

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