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Fractal Geometry in the Assessment of Oral Epithelial Dysplasia Grading System

Background: Oral epithelial dysplasia is linked to the possibility of progression to oral squamous cell carcinoma. The severity of atypic features and the height in the epithelium to which they extend have been used in grading dysplasia into mild, moderate and severe. Precise grading is a source of disagreement as the assessment carries a degree of subjectivity [1,2]. There is therefore a need for developing new morphological definitions for grading dysplasia based on research into the pathogenesis of premalignancy [3]. The aim of this study is developing objective aids in the diagnosis and classification of epithelial dysplasia based on image analysis, and using mathematical descriptors of morphology, both at the tissue and cellular levels.

Materials and Methods: Eighty images of haematoxylin and eosin stained dysplasia images (mild (25), moderate (27), severe (28)) were analyzed to extract the epithelial connective tissue interface (ECTI) profiles using different thresholding methods. Box counting, local and local connected fractal geometry techniques were then applied to assess the complexity of the ECTI profiles. The spatial distribution of a set of dysplasia cell nuclei were also assessed in different dysplasia grades. Statistical analyses to compare the different grades of dysplasia were performed.

Results: Preliminary results showed that the global complexity of ECTI profiles as described by the box fractal dimension (DBOX) was statistically different between mild (DBOX= 1.09) and both moderate (DBOX=1.13) and severe dysplasia (DBOX=1.14) ($p< 0.05$, one-way ANOVA), while moderate and severe dysplasia did not show any significant difference. The local connected fractal dimension (LCFD) was not statistically different between mild (LCFD=1.34), moderate (LCFD=1.34) or severe dysplasia (LCFD=1.34) ($p> 0.05$, one- way ANOVA).

Conclusion: The initial results of this study agree with our previous findings [4,5] and provides further evidence that the traditional classification of dysplastic changes into three grades might not represent accurately the morphological characteristic of the premalignant change This emphasizes the problems of using methods that have elements of subjectivity. A quantitative classification system is therefore a

much preferred options. The use of quantifiable methods such as different measures of fractal geometry might be of use in establishing new, reproducible systems.

References

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