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Computer Aide Discrimination of Benign and Malignant Thyroid Nodules by Ultrasound Imaging

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Abstract : Introduction: Thyroid nodules have an incidence of 33-68% in the general population. More than 5-15% of these nodules are malignant. Early detection and treatment of thyroid nodules increase the cure rate and provide optimal treatment. Between the medical imaging methods, Ultrasound is the chosen imaging technique for assessment of thyroid nodules. The confirming of the diagnosis usually demands repeated fine-needle aspiration biopsy (FNAB). So, current management has morbidity and non-zero mortality. Objective: To explore diagnostic potential of automatic texture analysis (TA) methods in differentiation benign and malignant thyroid nodules by ultrasound imaging in order to help for reliable diagnosis and monitoring of the thyroid nodules in their early stages with no need biopsy. Material and Methods: The thyroid US image database consists of 70 patients (26 benign and 44 malignant) which were reported by Radiologist and proven by the biopsy. Two slices per patient were loaded in Mazda Software version 4.6 for automatic texture analysis. Regions of interests (ROIs) were defined within the abnormal part of the thyroid nodules ultrasound images. Gray levels within an ROI normalized according to three normalization schemes: N1: default or original gray levels, N2: +/- 3 Sigma or dynamic intensity limited to μ+/- 3σ, and N3: present intensity limited to 1% - 99%. Up to 270 multiscale texture features parameters per ROIs per each normalization schemes were computed from well-known statistical methods employed in Mazda software. From the statistical point of view, all calculated texture features parameters are not useful for texture analysis. So, the features based on maximum Fisher coefficient and the minimum probability of classification error and average correlation coefficients (POE+ACC) eliminated to 10 best and most effective features per normalization schemes. We analyze this feature under two standardization states (standard (S) and non-standard (NS)) with Principle Component Analysis (PCA), Linear Discriminant Analysis (LDA) and Non-Linear Discriminant Analysis (NDA). The 1NN classifier was performed to distinguish between benign and malignant tumors. The confusion matrix and Receiver operating characteristic (ROC) curve analysis were used for the formulation of more reliable criteria of the performance of employed texture analysis methods. Results: The results demonstrated the influence of the normalization schemes and reduction methods on the effectiveness of the obtained features as a descriptor on discrimination power and classification results. The selected subset features under 1%-99% normalization, POE+ACC reduction and NDA texture analysis yielded a high discrimination performance with the area under the ROC curve (Az) of 0.9722, in distinguishing Benign from Malignant Thyroid Nodules which correspond to sensitivity of 94.45%, specificity of 100%, and accuracy of 97.14%. Conclusions: Our results indicate computer-aided diagnosis is a reliable method, and can provide useful information to help radiologists in the detection and classification of benign and malignant thyroid nodules.

Keywords : ultrasound imaging, thyroid nodules, computer aided diagnosis, texture analysis, PCA, LDA, NDA
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