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Quantitative Texture Analysis of Shoulder Sonography for Rotator Cuff Lesion Classification

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Abstract : In many countries, the lifetime prevalence of shoulder pain is up to 70%. In America, the health care system spends 7 billion per year about the healthy issues of shoulder pain. With respect to the origin, up to 70% of shoulder pain is attributed to rotator cuff lesions This study proposed a computer-aided diagnosis (CAD) system to assist radiologists classifying rotator cuff lesions with less operator dependence. Quantitative features were extracted from the shoulder ultrasound images acquired using an ALOKA alpha-6 US scanner (Hitachi-Aloka Medical, Tokyo, Japan) with linear array probe (scan width: 36mm) ranging from 5 to 13 MHz. During examination, the postures of the examined patients are standard sitting position and are followed by the regular routine. After acquisition, the shoulder US images were drawn out from the scanner and stored as 8-bit images with pixel value ranging from 0 to 255. Upon the sonographic appearance, the boundary of each lesion was delineated by a physician to indicate the specific pattern for analysis. The three lesion categories for classification were composed of 20 cases of tendon inflammation, 18 cases of calcific tendonitis, and 18 cases of supraspinatus tear. For each lesion, second-order statistics were quantified in the feature extraction. The second-order statistics were the texture features describing the correlations between adjacent pixels in a lesion. Because echogenicity patterns were expressed via grey-scale. The grey-scale co-occurrence matrixes with four angles of adjacent pixels were used. The texture metrics included the mean and standard deviation of energy, entropy, correlation, inverse different moment, inertia, cluster shade, cluster prominence, and Haralick correlation. Then, the quantitative features were combined in a multinomial logistic regression classifier to generate a prediction model of rotator cuff lesions. Multinomial logistic regression classifier is widely used in the classification of more than two categories such as the three lesion types used in this study. In the classifier, backward elimination was used to select a feature subset which is the most relevant. They were selected from the trained classifier with the lowest error rate. Leave-one-out cross-validation was used to evaluate the performance of the classifier. Each case was left out of the total cases and used to test the trained result by the remaining cases. According to the physician’s assessment, the performance of the proposed CAD system was shown by the accuracy. As a result, the proposed system achieved an accuracy of 86%. A CAD system based on the statistical texture features to interpret echogenicity values in shoulder musculoskeletal ultrasound was established to generate a prediction model for rotator cuff lesions. Clinically, it is difficult to distinguish some kinds of rotator cuff lesions, especially partial-thickness tear of rotator cuff. The shoulder orthopaedic surgeon and musculoskeletal radiologist reported greater diagnostic test accuracy than general radiologist or ultrasonographers based on the available literature. Consequently, the proposed CAD system which was developed according to the experiment of the shoulder orthopaedic surgeon can provide reliable suggestions to general radiologists or ultrasonographers. More quantitative features related to the specific patterns of different lesion types would be investigated in the further study to improve the prediction.

Keywords : shoulder ultrasound, rotator cuff lesions, texture, computer-aided diagnosis
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