Computer-aided classification of inflammatory sacroiliitis in magnetic resonance imaging

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evaluation. The system only requires the selection of a point within the VCF and will be made fully automatic in future work.

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Computer-aided classification of inflammatory sacroiliitis in magnetic resonance imaging

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Keywords Computer-assisted diagnosis · Inflammation · Rheumatology · Pattern recognition

Purpose

The reference standard to evaluate active inflammation of sacroiliac joints (SIJ) in spondyloarthritis (SpA) is magnetic resonance imaging (MRI). However, this evaluation may be challenging to specialists due to clinical variability [1]. In order to aid the diagnosis of inflammatory sacroiliitis, we aim to develop a computerized semi-automatic classification of SIJ using gray-level and texture MRI features. We also aim to assess the performance of the classification with features extracted from manually segmented SIJ images and from images processed by the warp geometric transformation method.

Methods

We retrospectively evaluated the SIJ MRI from 51 patients. Patients had inflammatory low back pain and were investigated for inflammatory sacroiliitis related to SpA. According to ASAS group MRI criteria [2], 22 patients presented active SIJ inflammation, and 29 were negative for SIJ active inflammation. A musculoskeletal radiologist performed manual SIJ segmentation independently and blinded to clinical and MRI diagnosis. Segmentation was performed in 6 consecutive SPAIR T2 coronal plane MRI for each patient. On each image we applied the warp processing method, in order to remove the black background of the segmented regions of interest (Fig. 1), which could introduce noise in the feature extraction and classification processes. A total of 39 features were extracted from each image (7 gray-level features, 14 texture features proposed by Haralick and 18 proposed by Tamura [3, 4]). Each patient was characterized by four vectors of feature categories: (a) Gray-level (7 features $\times$ 6 images $=$ 42 dimensions); (b) Haralick (14 features $\times$ 6 images $=$ 84 dimensions); (c) Tamura (18 features $\times$ 6 images $=$ 108 dimensions); and (d) All features combined (39 features $\times$ 6 images $=$ 234 dimensions). Classification was performed by the multilayer perceptron (MLP) artificial neural network, with a tenfold cross-validation. The diagnostic performance was assessed by the area under the receiver operating characteristic curve (AUC).

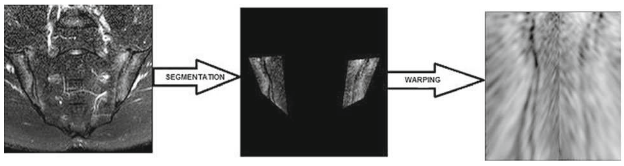

Fig. 1 Sacroiliac joints MRI segmentation and warping processes

Results

Figure 2 presents the classification results obtained using warped and segmented images with different vectors of feature categories. The warp method improved the classification performance in the majority of scenarios, and the highest difference was obtained by the gray-level feature vector, with an increase of 0.21 in AUC. On the other hand, the segmented images obtained highest performance only with Tamura features, with an increase of 0.30 in AUC. However, the best result with highest AUC (0.93) was obtained using all features extracted from the warped images, with sensibility of 0.73 (95% confidence interval of 0.50–0.88) and a specificity of 0.9 (95% confidence interval of 0.72–0.97).

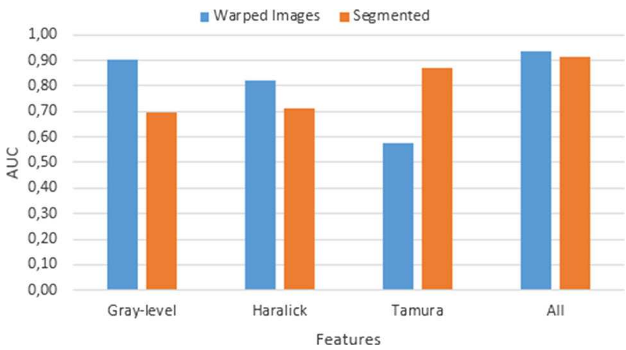

Fig. 2 Classification performance of categories of features extracted from warped and segmented SIJ images

Conclusion

This study on semi-automatic classification of active sacroiliitis in SpA achieved promising results for a case-based evaluation, with AUC of 0.93 using gray-level and texture MRI features extracted from SIJ images. The warp image processing method increased the overall classification performance compared to segmented images with a black background, except when Tamura features were employed. In future studies, we will extract different features from the warped images, e.g. Fourier and wavelet transformations, and perform an image-based evaluation for each SIJ MRI coronal slice. Further experiments will include an observer test to validate the semi-automatic classification as a computer-aided diagnosis tool.

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Computer-aided diagnosis of sacroillitis in CT scans: method and preliminary results

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Keywords Sacroillitis · Recognition · Computational radiology · Classification

Purpose

Sacroiliitis is an important clinical and diagnostic feature of spondyloarthropathy (SpA). It may present itself with non-specific low back pain and ambiguous physical examination. Thus, many undiagnosed SpA patients undergo lumbar spinal CT as part of their lower back pain workup. Routine radiological assessment of the sacroiliiac joints and detection of sacroiliitis-related CT findings may allow for earlier diagnosis and prompt the initiation of therapy to decrease pain and to prevent irreversible joint damage. However, in many instances, the sacroiliiac joints in this setup are overlooked and/or misdiagnosed on the CT scans.

Methods

We have developed a fully automatic method for the detection of the grading sacroiliitis in of sacroiliitis in CT scans. The method inputs a lumbar spinal CT scan. It outputs a sacroiliitis grading—grade 0: healthy; grade 1: doubtful; grade 2: mild; grade 3–4: advanced-ankylosed. The method consists of four steps:

1. Computation of the sacroiliiac joints region of interest (ROI). The ROI for the left and the right sides are computed by first segmenting the sacrum and the illium surfaces with the the graph min-cut algorithm and then extracting the respective sacrum and illium bone cortical surfaces. The ROI around the sacroiliiac joint in each slice is a 2D rectangular 35 × 8 mm ROI oriented along the surfaces medial axis.
2. Extraction of 2D image patches in the ROI axial slices. The image patches are of size 21 × 21 pixels (5 × 5 mm^2) and are aligned vertically.
3. Labelling of the extracted image patches as healthy/diseased using a pre-trained image patch classifier.
4. Grading of the CT scan based on the image patches labels assigned in step 3 with a bag-of-words classifier.

The image patch classifier used in step 3 is trained with radiologist-tagged CT slices in the sacroiliiac joint ROI. The classifier is constructed with the Support Vector Machine (SVM) method. Figure 1 illustrates the steps of our method on an example.

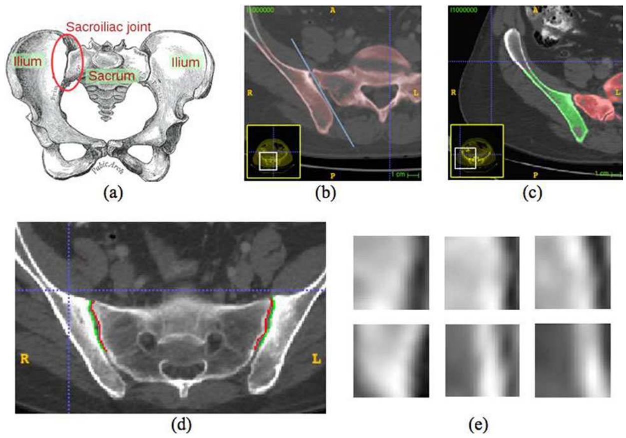

Fig. 1 (a) sacrum, ilium, and sacroiliac; (b) line separating the sacrum and ilium on an axial slice; (c) segmentation of the ilium (green) and sacrum (red) with the graph min-cut algorithm; (d) sacroiliac joint ROI; (e) representative image patches from the sacroiliac joint ROI

Results

To evaluate our method, 150 CT scans were retrospectively selected from our institution. The 300 sacroiliac jointsacroiliiac joints were evaluated and graded according to the presence of subchonral erosions/sclerosis/ankylosis (NY criteria) by an expert musculoskeletal radiologist: 119 joints were are grade 0, 51; grade 1, 70; grade 2, 60; grades 3–4. Each ROI consisted of about 500 image patches. A total of 496 diseased patches were then manually selected, and 3175 healthy patches were automatically selected. The training was performed on 80% of the ROI patches. The remaining 20% and additional validation datasets were used for testing.

The segmentation accuracy was: 78.5%; for grade 0, 66.1%; for grade 1, 75.8%; for grade 2, and 68.6%; for grades 3–4. The classifier accuracy on the test set iswas: 68.9%; for grade 0, 70.5%; for grade 1, 48.9%; for grade 2, and 61.8%; for grades 3–4. Overall, for the 300 SIJ, the classifier accuracy was 72.25% (all grades) on about 3700 patches.

Conclusion

Our preliminary results indicate that computer-based diagnosis of sacroiliitis Our method may be a useful tool for the detection and grading of sacroiliitis diagnosis and grading ion CT scans. Ongoing and future work includes improve the segmentation success to ~85%, improve automatic healthy patches identification, securing a larger training set, and exploring advanced learning methods, e.g., deep convolutional neural networks.

Computer assisted identification of acute ischemic infarct using CT number and wavelet features from CT images

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Keywords CT · Acute ischemic infarct · Wavelet energy · Random forest

Purpose

Computed Tomography (CT) images are used in initial diagnosis of stroke. Acute ischemic stroke lesion appears as hypo-intense lesion in CT Images. As infarct is iso-intense in nature with the CSF and lateral ventricle, a supervised approach based of random