Hepatic fibrosis: Clinical background and computational evaluation of CT images using statistical shape model.*

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Abstract—The degree of fibrosis is one of the important prognostic factors in patients with chronic liver disease. We investigated the usefulness of statistical shape models (SSMs) for shape classification to evaluate liver fibrosis on CT images. Our results showed that a combination of a SSM and support vector machine (SVM) analysis of CT images can help estimate the degree of liver fibrosis.

I. INTRODUCTION

Patients with chronic liver disease can develop hepatic fibrosis, cirrhosis, and hepatocellular carcinoma. The degree of fibrosis is one of the most important prognostic factors in patients with chronic liver disease. Biopsy is the most widely accepted gold standard in the evaluation of liver fibrosis, however it is an invasive procedure that has a risk of serious complications. Therefore, various types of techniques have been proposed to evaluate the degree of liver fibrosis less invasively.

We have effectively utilized statistical shape models (SSMs) of the abdominal organs to perform their segmentation from CT data [1]. In this study, we investigated the usefulness of SSM not only for segmentation but also for shape classification to evaluate liver fibrosis.

II. METHODS

Ninety-three subjects (45 male, 48 female; age range 20-75 years) were included in this retrospective study. Of the 93 subjects, 54 were potential liver donors and 39 were patients with chronic liver diseases (19 were patients who underwent hepatectomy to treat hepatic tumors, and 20 were patients who underwent liver transplantation to treat severe cirrhosis). For the 56 patients with chronic liver diseases, fibrosis stages were histopathologically determined according to the established criteria (New Inuyama Classification). For the remaining 55 potential liver donors, stages were estimated as F0 (no fibrosis) without histopathologic examination. Therefore, the subjects were classified according to fibrosis stage as follows: F0 (n=55); F1 (6); F2 (3); F3 (1); and F4 (28). Each subject underwent contrast enhanced CT using a 64 channel multi-detector row scanner (0.625-mm slice thickness). An abdominal radiologist manually traced the liver boundaries on every CT section using an image workstation, and the boundaries were used for the following analyses.

A SSM was constructed by using principal component analysis of the subject dataset, which defined a parametric model of the liver shapes [1]. The shape parameters were calculated by fitting the SSM to the segmented liver shape of each subject, and then used for training of a linear support vector machine (SVM), which classifies the liver fibrosis grade, so as to maximize the area under the receiver operating characteristic (ROC) curve (AUC). The SSM and SVM were constructed and validated in a leave-one-out manner using the 93 subject data.

III. RESULTS

In our SSM and SVM model, AUC values for the classification of liver fibrosis were 0.939 (F0 vs. F1-4), 0.910 (F0-1 vs. F2-4), 0.928 (F0-2 vs. F3-4), 0.890 (F0-3 vs. F4) (Fig.1).

![Figure 1. Receiver operating characteristic (ROC) curve of our SSM and SVM model for the classification of liver fibrosis (F0-2 vs. F3-4). The area under the curve (AUC) was calculated as 0.928.](image-url)

IV. CONCLUSION

A combination of a SSM and SVM analysis of CT images can help estimate the degree of liver fibrosis.

REFERENCES


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