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ESTIMATING LIVER STEATOSIS: CAN ARTIFICIAL NEURAL NETWORK AND IMAGE ANALYSIS IMPROVE THE ACCURACY

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Introduction/ Background

Liver steatosis is very important in transplantation pathology as it directly influences the graft dysfunction. Pretransplant donor biopsy materials are evaluated by the pathologists, and degree of steatosis, especially large droplet steatosis (LDS) which is described as lipid droplets with a diameter of at least 15 micron, is estimated under light microscope. But when doing so, there can be great intra- and inter-observer variability. In order to overcome this problem several automated systems and image analysis methods are used.

Aims

The most challenging issue for automated steatosis image analysis is to distinguish real oil droplets from sinusoidal regions. Although some morphometric features are employed to make this discrimination, whole feature space could not be represented for a fatty liver cell. In this study we have contributed a new approach, which tries to solve this discrimination issue with an artificial learning system.

Methods

Ten consecutive hematoxylin and eosin (HE) stained, formalin fixed paraffin embedded donor liver biopsies, reported by 2 pathologist, were evaluated by a third pathologist and steatosis percentage was given as total and LDS by using the percentage of area occupied by lipid droplets to total biopsy area. Automated image analysis was performed on about 200 photographs taken to represent the whole biopsy at X20 magnification by Zeiss Axio Scope.A1 microscope using Kameram™ software and established as percentage of LDS to total biopsy area. Segmented positive (oil) and negative (non- oil) components are labeled by an expert pathologist and after some preprocesses they are fed to an Artificial Neural Network for training. We have used about 1000 droplets for training and 1500 droplets for performance evaluation. The proposed scheme is utilized to calculate liver fat ratio on digital images and the results are compared with expert's opinions.

Results

There was great variation among pathologists and when compared to the automated analysis and pathologists were prone to overestimate the steatosis <Table 1>. As this overestimation can lead to nonuse of the donor liver, the accurate assessment of the steatosis is critical. Since the biopsy is the gold standard for the assessment of steatosis, methodology of this examination should be as objective as possible. Our results show that automated assessment of liver steatosis is very useful in order not to loose donor livers, by overestimation. Automated image analysis used before were based on morphometric features of liver droplet regions, and use of this Artificial Neural Network for training to discriminate sinusoidal areas from lipid areas reached a high accuracy. In this study, we proposed a new approach to discriminate lipid areas from sinusoids without using morphometric features, which needs be confirmed in a large cohort. The performance can be improved by employing some different pattern classification techniques such as Support Vector Machines as a future study.

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Patient ID	System TDS	System LDS	Expert 1-2 TDS	Expert 1-2 LDS	Expert 3 TDS	Expert 3 LDS
1	8.8	5.5	30	25	25	15
2	6.5	2.6	15	10	35	5
3	8	6	25	20	35	30
4	6.1	3.7	13	8	15	5
5	4.3	1.9	10	8	25	5
6	5.1	2	8	3	25	
7	8.2	4.3	20	15	35	20
8	11.8	9.6	30	20	45	25
9	11	7.4	25	15	35	25

Table 1: The total droplet steatosis (TDS) and large droplet steatosis (LDS) percentages estimated by the pathologists and calculated by the software