Accurate detection of septa and nodules in NASH cirrhosis with AI-based model

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Use of second-harmonic generation microscopy for automated detection of septa and nodules in needle liver biopsies of NASH cirrhosis

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1 Introduction

- Cirrhosis, previously considered irreversible, is now recognized as capable of regression or progression. Most staging systems oversimplify all degrees of cirrhosis into one category.
- Portal hypertension, defined by hepatic venous pressure gradient (HVPG), correlates with key histological features of cirrhotic liver biopsies, including septa and nodules, which might make a biopsy an acceptable surrogate for clinical outcome.

2 Aim

Using second harmonic generation/two-photon excitation fluorescence (SHG/TPEF), this exploratory analysis aims to develop an artificial intelligence (AI) tool based on septa and nodule microscopy for use in natural history monitoring and evaluate treatment response in cirrhotic NASH trials.

3 Method

- 25 liver biopsies from 15 NASH patients with compensated cirrhosis were included from a phase 2a trial.
- Digitized images stained with Sirius red and immunostain for smooth muscle actin were used by an expert pathologist to identify all septa and cirrhotic nodules.
- 2 image algorithms were developed to automatically detect septa and nodules based on pathologist's annotations, named qSepta and qNodules, respectively.
- Agreement between the algorithm detection results and annotations were determined, and the images were rotated to establish repeatability. (Fig.1)

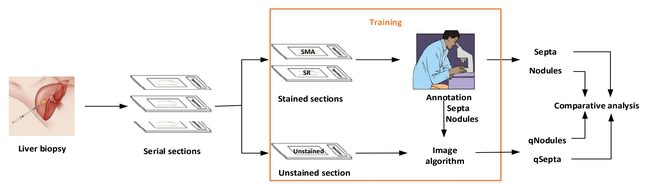

Figure 1. Overview of algorithms for automated detection of septa and nodules in needle biopsy of NASH cirrhosis.

4 Results

- Concordance between the pathologist annotations and algorithm identification was determined after excluding technical artifacts. (Fig.2,Tab.1)
- 284 septa were annotated by the pathologist ("true septa") and 294 septa were detected from the SHG/TPEF images using qSepta algorithm. Comparing the qSepta results versus true septa, 91% of the true septa were detected by the algorithm and 85% of the algorithm detection results were true septa.
- 587 nodules were annotated from 25 H&E images by the pathologist. 525 nodules were detected from the SHG/TPEF images using qNodules. Comparing the qNodules results and true nodules, 82% of the true nodules were detected by the algorithm and 95% of the algorithm detection results were true nodules.
- The repeatability of qSepta and qNodules were 95% and 99% respectively.

4 Results continued

Septa annotated by pathologist | Septa annotated by algorithm

Nodules annotated by pathologist | Nodules annotated by algorithm

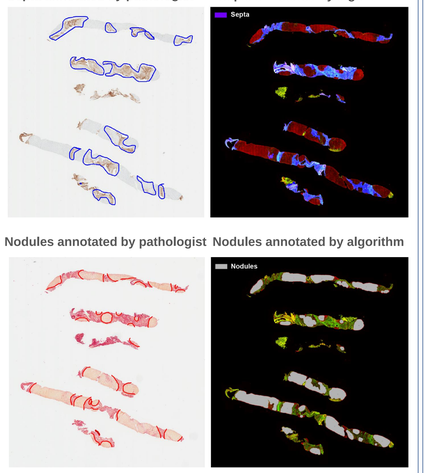

Figure 2. Examples of septa and nodules detection.

Septa				
	Pathologist	qSepta	Overlap for Pathologist	Overlap for qSepta
Number	284	294	258	251
Sensitivity or PPV			91% (258/284)	85% (251/294)

Nodule				
	Pathologist	qNodule	Overlap for Pathologist	Overlap for qNodule
Number	587	525	483	499
Sensitivity or PPV			82% (483/587)	95% (499/525)

Table 1. Results of septa and nodules detection.

5 Conclusions

- qSepta and qNodules algorithms can accurately detect septa and nodules in NASH cirrhotic patients.
- This can be used to develop more sophisticated algorithms to correlate with HVPG and study the natural history of NASH cirrhosis and treatment response.

6 Acknowledgements

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7 References

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8 Contact information

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