

INTRODUCTION

Liver steatosis is an important indicator of liver health that can be accurately measured non-invasively using magnetic resonance imaging (MRI) or magnetic resonance spectroscopy (MRS) methods. Artificial neural networks (ANN) now offer the ability to deliver quantitative assessments of steatosis in near real-time without the need for special expertise or training in image data analysis.

AIM

The aim of this study is to compare the diagnostic ability of an ANN for predicting liver steatosis grades in biopsy against MRS measurements.

METHOD

- Fifty patients (36 with NAFLD including 9 with NASH) aged 7 to 19 years undergoing percutaneous liver biopsy at Children's Healthcare of Atlanta for any reason were recruited¹.
- MRI scans (1.5T Siemens Aera) were performed within 3 days of the liver biopsy.
- Liver spectra were acquired using the HISTO sequence and volumetric liver fat fraction (VLFF) data were acquired via the HepaFat-AI[®] protocol.
- MRI data were automatically processed using a FDA-cleared ANN (HepaFat-AI[®]) for simultaneously measuring VLFF, proton density fat fraction (PDFF) and steatosis grade.
- Liver PDFFs were obtained from automatically generated HISTO reports.
- The steatosis grade was independently and blindly assessed by an expert pathologist.
- Pre-defined VLFF and PDFF thresholds and the area under the receiver operating characteristic curve (AUROC) were used to assess the diagnostic accuracy of each method against histology.

RESULTS

Excluding one case that had an ANN result, but no MRS result, the two techniques classified exactly the same cases at the grade 0 vs 1-3 boundary using previously defined VLFF² and PDFF³ thresholds (Figure 1).

ANN VLFF (HepaFat-AI[®]) returned AUROCs of 0.95 (0.88-1.00), 0.96 (0.92-1.00), and 0.97 (0.94-1.00) for the detection of liver steatosis at grade 0 vs 1-3, grade 0-1 vs 2-3, and grade 0-2 vs 3, respectively. MRS-PDFF showed AUROCs of 0.96 (0.91-1.00), 0.97 (0.93-1.00), and 0.97 (0.92-1.00) at the same steatosis grade boundaries (Table 1). There were no statistically significant differences between the ANN-VLFF and MRS-PDFF AUROCs at any threshold.

Steatosis Grade	MRS PDFF AUROC	ANN-VLFF AUROC
0 vs 1-3	0.96 (0.91-1.00)	0.95 (0.88-1.00)
0-1 vs 2-3	0.97 (0.93-1.00)	0.96 (0.92-1.00)
0-2 vs 3	0.97 (0.92-1.00)	0.97 (0.94-1.00)

Table 1. Areas under ROC curves for MRS-PDFF and ANN-VLFF at three steatosis grade boundaries.

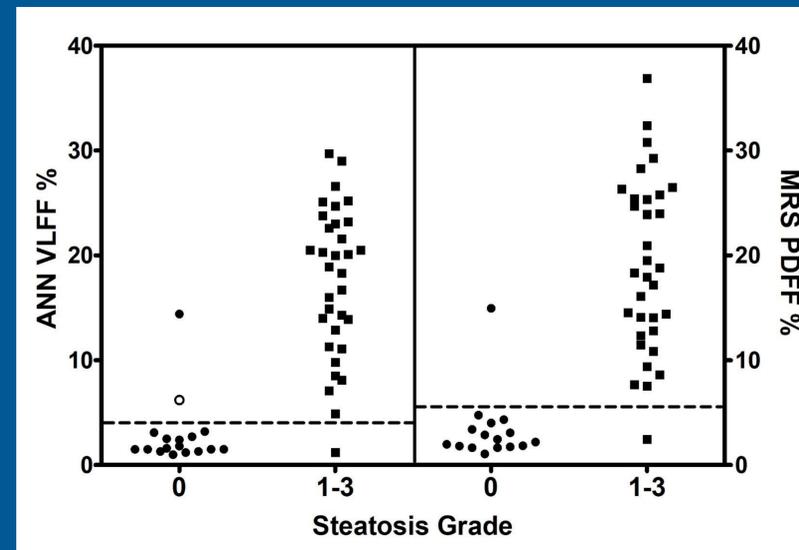


Figure 1. Diagnostic accuracy of ANN VLFF (left) and MRS-PDFF (right) compared to the steatosis grade determined by the pathologist. Hepatic steatosis was defined by the pathologist as a grade of 0 (no steatosis - circles) or a grade 1 and above (some steatosis - squares). The open circle is an ANN VLFF result that does not have a corresponding MRS-PDFF result. A threshold point of 4.1% VLFF, as determined previously, (St. Pierre et al. 2016) was used. The MRS-PDFF threshold of 5.56% was derived from Szczepaniak et al. 2005.

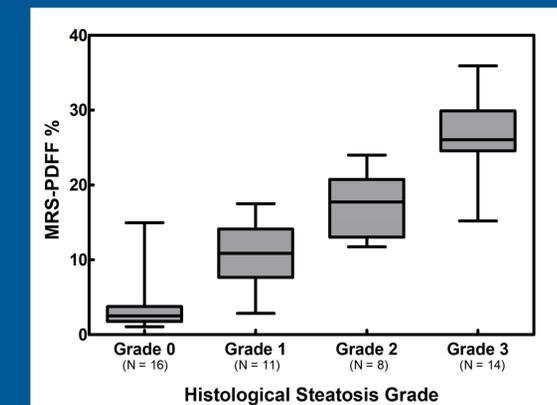
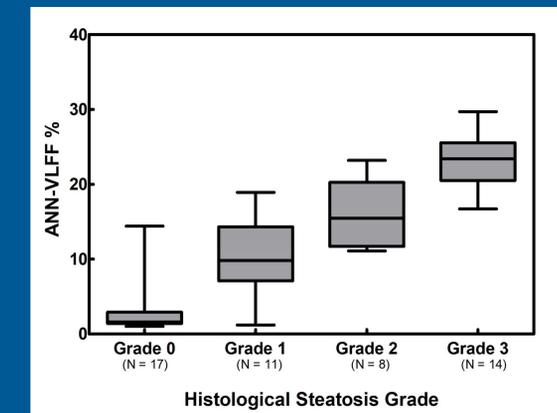


Figure 2. Box and whisker plots of steatosis grade versus ANN-VLFF (Top) and MRS-PDFF (Bottom). The horizontal bar in the box is the median and the tails are the minimum and maximum.

CONCLUSIONS

The accuracy of the ANN for diagnosing different grades of liver steatosis is equivalent to a conventional MRS technique. Using the ANN eliminates the need for image analysis or other technical expertise and speeds up reporting to an extent that point-of-care screening could be performed and costs associated with analysis greatly reduced.

REFERENCES

- 1) Vos MB, Castillo-Leon E, Knight-Scott J, et al. Validation of MRI-VLFF for the non-invasive measurement of steatosis in children. *GastroHep*. 2020 Jul;2(4):171-80.
- 2) St Pierre TG, House MJ, Bangma SJ, et al. Stereological Analysis of Liver Biopsy Histology Sections as a Reference Standard for Validating Non-Invasive Liver Fat Fraction Measurements by MRI. *PLoS One*. 2016;11(8):e0160789.
- 3) Szczepaniak LS, Nurenberg P, Leonard D, et al. Magnetic resonance spectroscopy to measure hepatic triglyceride content: prevalence of hepatic steatosis in the general population. *American Journal of Physiology-Endocrinology and Metabolism*. 2005;288(2):E462-E468.

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CONTACT INFORMATION

MichaelH@resonancehealth.com
 SusannaK@resonancehealth.com
 info@resonancehealth.com