Discrepancies in Ultrasound Assessment of Fatty Liver Disease

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Background
25-30% of the population is affected by non-alcoholic fatty liver disease (NAFLD)[1] In alcoholic fatty liver disease, rates are closely correlated with patterns of alcohol consumption.

In Hull, the hospital admission rate for NAFLD was higher than the national and regional average (3.9 per 100,000 compared to 3.0 and 3.8 respectively)[2] Fatty liver disease can cause hepatocellular cancer, the incidence of which almost doubled from the 1980s to the 2000s in the Western world[3]. Therefore, it is beneficial to detect fatty liver disease early, before progression to cancer. Liver biopsy is the gold standard test but due to the fact that it is invasive, ultrasound scans are commonly used for diagnosis[4]

Study Rationale
The rationale for this study was to better understand if sonographers in Hull had an agreement rate in reporting fatty liver that is comparable to known agreement rates of 72%[5] – for the diagnosis of fatty liver disease (alcoholic or non-alcoholic). Hull has a particularly high rate of hospital admissions for NAFLD[2]; therefore, accurate diagnosis is important. As known agreement rates have been found to be poor in previous studies, it is important to find out if the local areas' results fall in line with these studies or is found to be anomalous.

The primary aim of this study was to identify the agreement rates of sonographers in Hull when diagnosing and staging fatty liver disease. This was to be compared with previous studies on agreement rates to see if there were similarities in the results.

The secondary aim was to identify any correlations between the experience of a sonographer and their ability to accurately diagnose and grade patients with fatty liver disease.

Ultrasound of the Liver
Determining the extent of disease within the liver is dependent upon tissue brightness, liver to kidney contrast, and deep beam attenuation, as well as changes in vessel walls and gallbladder definition[6]. In the case of bright vessel walls and gallbladder definition, previous studies have not been able to show exactly how well they perform as a diagnostic tool in fatty liver disease[7]. Typically, the fatty liver appears as a homogeneous structure with an increased echogenicity compared to the renal cortex[8] Therefore, the renal cortex, if visible, can be used as a baseline to compare the brightness of the liver to on examination.

Methodology
25 images of livers were selected randomly from a cohort of patients attending for liver scans. All patients presented with abnormal liver function tests with the clinical suspicion of fatty liver disease. The images were anonymised. Sonographers were asked to review the images and score as per the results table 3

Results

Sonographer Response Rate = 60%

Table 1:
Range of experience of sonographer responding to survey

Duration of experience (years)	Number
< 1	1
1 - 5	3
5 - 10	1
>10	10

Results
There was significant variability in the assessment of fatty liver disease on ultrasound across the 15 sonographers regardless of experience This was more significant when trying to determine the grade of those that appeared to have the disease.

Of the 25 images analysed, there was 100% agreement on only one of them. For 4r images, sonographers gave answers that ranged from "normal" to "severe fatty liver disease". A further 13 images received diagnoses ranging from "mild" to "severe fatty liver disease".

In total, there were 23 images in which at least 2 sonographers said there was some disease present. Of these, there were only 4 images where more than two thirds came to the same conclusion regarding grade. Agreement rates were significantly better when trying to determine the presence of disease at all. For 22 of the 25 images there was more than two thirds agreeing on the presence or absence of disease.

On 13 out of 25 cases, there was unanimous agreement about whether the image was of a patient with or without fatty liver infiltration. The overall agreement for determining the presence of disease was 48%. Of the remaining images, 4 had a particularly low percentage agreement compared to other results when determining the grade of disease.

There were few situations in which sonographers were unable to give an opinion. However, there were 2 images where 3 could not give an opinion, and 1 image where 2 sonographers were not able to.

For the cases where a sonographer was unable to give an opinion, all but one had greater than 10 years of experience.

Summary of Findings
Agreement on the stage NAFLD was found to be poor, with no instances in which there was unanimous agreement regarding the grade.

The level of experience did not appear to make a difference when trying to diagnose patients. However, those with greater than 10 years of experience were more likely to say that they were unable to give an opinion on a given image. This was also more likely to be the case when most agreed that there was some disease present, but there was a lot of variability when determining the grade of the disease.

Overall, the findings appear to follow the pattern of previous studies that have shown that interobserver variability when attempting to grade patients with fatty liver disease is drastically lower than when attempting to say if a patient is positive or negative for the disease. This does not appear to change with experience of the sonographer.

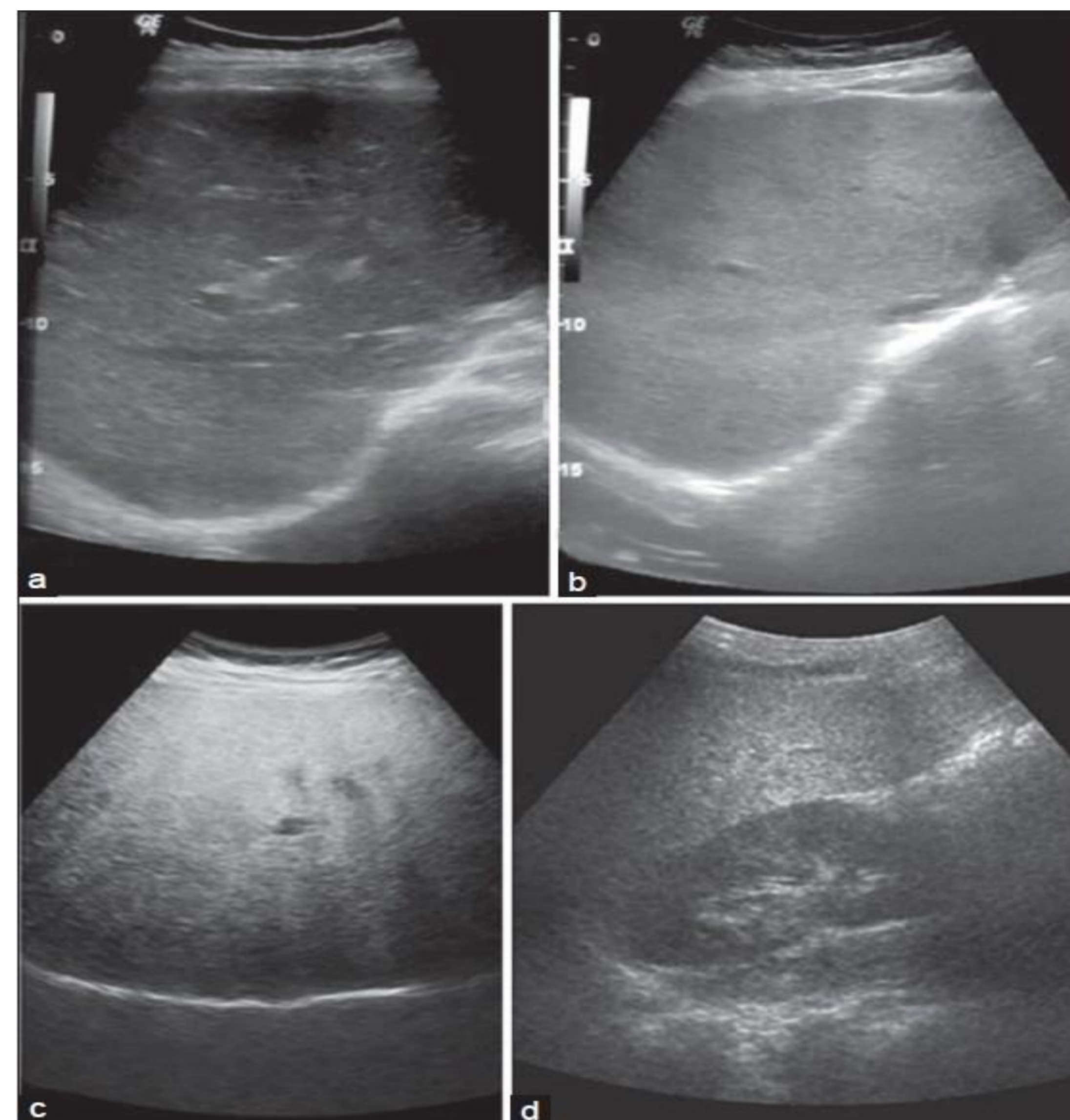| Image number	Normal	Fatty infiltration
1	100.00%	0.00%
2	93.33%	6.67%
3	0.00%	100.00%
4	0.00%	100.00%
5	0.00%	100.00%
6	0.00%	100.00%
7	0.00%	100.00%
8	0.00%	100.00%
9	33.33%	66.67%
10	0.00%	100.00%
11	6.67%	93.33%
12	15.38%	84.62%
13	0.00%	100.00%
14	7.14%	92.86%
15	0.00%	100.00%
16	7.14%	92.86%
17	0.00%	100.00%
18	53.33%	46.67%
19	0.00%	100.00%
20	80.00%	20.00%
21	0.00%	100.00%
22	30.77%	69.23%
23	33.33%	66.67%
24	14.29%	85.71%
25	21.43%	78.57%

Table 2:
Percentage of respondents assessing the presence of disease

Ultrasound image showing (a) normal liver; (b) mild fatty liver disease with increased echogenicity; (c) moderate fatty liver disease with increased echogenicity and obscured walls of portal venous branches; and (d) severe fatty liver disease where the diaphragmatic border is no longer visible.

Image number	Normal	Mild Fatty Infiltration	Moderate Fatty Infiltration	Severe Fatty Infiltration	Unable to give an opinion
1	100.00%	0.00%	0.00%	0.00%	0.00%
2	93.33%	6.67%	0.00%	0.00%	0.00%
3	0.00%	46.67%	46.67%	6.67%	0.00%
4	0.00%	0.00%	60.00%	40.00%	0.00%
5	0.00%	20.00%	60.00%	13.33%	6.67%
6	0.00%	33.33%	60.00%	6.67%	0.00%
7	0.00%	7.14%	71.43%	21.43%	0.00%
8	0.00%	0.00%	53.33%	46.67%	0.00%
9	33.33%	40.00%	26.67%	0.00%	0.00%
10	0.00%	20.00%	26.67%	46.67%	6.67%
11	6.67%	33.33%	40.00%	20.00%	0.00%
12	13.33%	0.00%	73.33%	13.33%	0.00%
13	0.00%	13.33%	46.67%	40.00%	0.00%
14	6.67%	13.33%	33.33%	40.00%	6.67%
15	0.00%	20.00%	33.33%	40.00%	6.67%
16	6.67%	33.33%	53.33%	0.00%	6.67%
17	0.00%	13.33%	40.00%	33.33%	13.33%
18	53.33%	26.67%	20.00%	0.00%	0.00%
19	0.00%	13.33%	66.67%	20.00%	0.00%
20	80.00%	13.33%	6.67%	0.00%	0.00%
21	0.00%	13.33%	33.33%	33.33%	20.00%
22	26.67%	13.33%	46.67%	0.00%	13.33%
23	30.77%	38.46%	0.00%	7.69%	23.08%
24	13.33%	26.67%	53.33%	0.00%	6.67%
25	20.00%	46.67%	26.67%	0.00%	6.67%

Table 3:
Percentage of grade of disease excluding respondents who replied "normal".

Conclusion
Inter-observer variability is a serious problem in assessing the grade of fatty liver disease.

Difficulty in determining whether or not patients have disease can result in misdiagnosis and inappropriate management of patients. In some cases, this may result in a missed diagnosis of fatty liver disease being left untreated. This would put the patient at risk for developing liver fibrosis, and potentially hepatocellular carcinoma.

Due to the lack of effective treatment and poor outcomes of hepatocellular cancer, more needs to be done to ensure that the rate of false negative results of fatty liver disease can be reduced.

Learning Outcomes
- Results need to be disseminated to sonographers to make them aware of the significant inter-observer variation
- Standardise liver imaging pre-set is required on all machines to minimise the impact of suboptimal machine settings affecting image display
- Sonographer workshop required to standardise interpretation and reporting of fatty liver.

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