Quantitative magnetic resonance imaging predicts individual future liver performance after liver resection for cancer

**BACKGROUND**
- The future liver performance (FLP) of an individual undergoing surgical liver resection to remove cancer is critical for their survival and recovery.
- We report the development and clinical testing of HepaT1ca, a novel magnetic resonance image (MRI) post-processing tool that combines quantitative multiparametric MRI with anatomical liver segmentation to estimate FLP.
- This is intended to inform the assessment of individualised operative risk and augment patient and surgeon decision making prior to liver resection.

**METHODS**
- This software combines iron-corrected T1 (cT1) mapping, previously demonstrated to correlate with fibro-inflammation and predict clinical outcomes in chronic liver disease, with a 3D U-net pipeline to delineate the liver volume followed by semi-automatic delineation of Couinaud segments based on anatomical landmarks.
- Interactive removal of these segments, along with any interactively-defined virtual wedge resections, allows accurate estimation of the future liver remnant (FLR) volume, which when combined with quantitative cT1 mapping, provides a prediction of FLP, termed the “HepaT1ca score.” The ability of this score to predict post-operative morbidity, length of stay and regenerative capacity was evaluated in a prospective clinical trial.

**LIVER PARENCHYMA CHARACTERISATION**
LiverMultiScan® allows non-invasive characterisation of the parenchymal liver tissue correlating with traditional biopsy derived histology measures of liver inflammation, ballooning and steatosis.

**CLINICAL TRIAL**
ClinicalTrials.gov/NCT03213314

**CLINICAL UTILITY**
- In favour of surgery
- Potential for extended hepatectomy

**LIVER REGENERATION**
- The pre-operative HepaT1ca score correlated with the achieved regeneration following anatomical resection for liver cancer. Within three months, patients with a higher pre-operative cT1 and low FLR had a lower achieved regeneration.

**CONCLUSION**
We demonstrate the utility of a non-invasive quantitative MRI approach for predicting postoperative liver performance. This has the potential to transform surgical decision-making and augment individualised risk assessment for patients undergoing liver resection for cancer.

**REFERENCES**
- University of Edinburgh, United Kingdom, St George’s Hospital Foundation Trust, Basingstoke, United Kingdom, NHS Lothian, Department of Surgery, Edinburgh, United Kingdom, Perspectum Diagnostics, Oxford, United Kingdom, NHS Lothian, Clinical Research Facility, Edinburgh, NHS Lothian, Clinical Radiology, Edinburgh, Edinburgh Clinical Trials Unit, Edinburgh, United Kingdom

**IMAGE ANALYSIS PIPELINE**

**PREDICTING LENGTH OF STAY**
In patients with a future liver remnant below 90%, a high mean cT1 (> 795ms) was associated with a longer duration of hospital stay of 6.5 (5.3-12) vs. 5 (4-7.1); median (IQR); P = 0.0053.

**PREDICTING OUTCOME**
The modified Hyder-Pawlik score was used to identify the 25% of patients with the poorest clinical outcome (sum of weighted bilirubin, creatinine & INR scores over 5 days post-surgery). A logistic regression was trained with nine pre-operative predictors to construct a composite predictive biomarker; in a test subset, this biomarker identified patients with a poor outcome with an AUC of 0.78.