

**ELECTRONIC SUPPLEMENTARY MATERIAL**

***Three-dimensional multifrequency magnetic resonance elastography improves preoperative assessment of proliferative hepatocellular carcinoma***

**Supplementary Table 1.** Multiparametric MRI protocol.

|                        | <b>Philips</b>        |              |                |              |              |                |
|------------------------|-----------------------|--------------|----------------|--------------|--------------|----------------|
|                        | <i>T1W</i>            | <i>T2W</i>   |                | <i>DWI</i>   | <i>DCE</i>   |                |
|                        | <i>Axial</i>          | <i>Axial</i> | <i>Coronal</i> | <i>Axial</i> | <i>Axial</i> | <i>Coronal</i> |
| TR (msec)              | 3.6                   | 2000         | 1100           | 1520         | 3.7          | 5.2            |
| TE (msec)              | 1.31                  | 66           | 80             | 70           | 1.32         | 1.07           |
| Flip angle (degrees)   | 10                    | 90           | 90             | 90           | 10           | 10             |
| Field of view (mm)     | 400×350               | 360×360      | 450×450        | 327×399      | 400×352      | 380×380        |
| Matrix                 | 252×217               | 288×288      | 320×282        | 108×128      | 268×234      | 212×212        |
| Section thickness (mm) | 4                     | 5            | 5              | 5            | 4            | 4.4            |
|                        | <b>Siemens</b>        |              |                |              |              |                |
|                        | <i>T1W</i>            | <i>T2W</i>   |                | <i>DWI</i>   | <i>DCE</i>   |                |
|                        | <i>Axial</i>          | <i>Axial</i> | <i>Coronal</i> | <i>Axial</i> | <i>Axial</i> | <i>Coronal</i> |
| TR (msec)              | 4.85                  | 3000         | 1200           | 6600         | 4.85         | 3.90           |
| TE (msec)              | 2.41                  | 95           | 91             | 62           | 2.41         | 1.49           |
| Flip angle (degrees)   | 10                    | 140          | 180            | 180          | 10           | 10             |
| Field of view (mm)     | 380×309               | 380×380      | 380×380        | 380×306      | 380×3093     | 360×360        |
| Matrix                 | 320×240               | 320×320      | 256×256        | 134×134      | 20×240       | 320×234        |
| Section thickness (mm) | 3                     | 5            | 6              | 5            | 3            | 3              |
|                        | <b>United Imaging</b> |              |                |              |              |                |
|                        | <i>T1W</i>            | <i>T2W</i>   |                | <i>DWI</i>   | <i>DCE</i>   |                |
|                        | <i>Axial</i>          | <i>Axial</i> | <i>Coronal</i> | <i>Axial</i> | <i>Axial</i> | <i>Coronal</i> |
| TR (msec)              | 120                   | 4000         | 1200           | 4258         | 4.15         | 4.31           |
| TE (msec)              | 2.28                  | 79.92        | 106.04         | 75           | 1.86         | 1.96           |
| Flip angle (degrees)   | 70                    | 90           | 125            | 90           | 10           | 10             |
| Field of view (mm)     | 410×280               | 380×360      | 400×380        | 380×300      | 400×300      | 360×350        |
| Matrix                 | 288×80                | 320×90       | 256×85         | 128×100      | 256×80       | 256×73         |
| Section thickness (mm) | 6                     | 6            | 7              | 6            | 5            | 6              |

**Note:** b values for DWI were 0, 50, and 800 s/mm<sup>2</sup>. T1WI: T1-weighted images; T2WI: T2-weighted images; DWI: diffusion-weighted imaging; DCE: dynamic contrast-enhanced; TE: echo time; TR: repetition time.

**Supplementary Table 2.** Demographics and clinical characteristics of the participants in this study.

| Characteristic                         | Training cohort<br>(n=121) | Validation cohort<br>(n=33) | p value |
|----------------------------------------|----------------------------|-----------------------------|---------|
| <b>Demographic</b>                     |                            |                             |         |
| Age (years) (mean $\pm$ SD)            | 59 $\pm$ 11                | 56 $\pm$ 11                 | 0.07    |
| Sex (male: female)                     | 101:20                     | 29:4                        | 0.54    |
| BMI (kg/m <sup>2</sup> )               | 23.96 $\pm$ 3.27           | 24.46 $\pm$ 3.18            | 0.43    |
| Cirrhosis                              | 81(66.94%)                 | 23 (69.7%)                  | 0.77    |
| Etiology                               |                            |                             | 0.12    |
| Hepatitis virus                        | 105 (86.78%)               | 25(75.76%)                  |         |
| Non-hepatitis virus                    | 16 (13.22%)                | 8(24.24%)                   |         |
| <b>Preoperative laboratory results</b> |                            |                             |         |
| Albumin (g/dL)                         | 39.27 $\pm$ 5.33           | 38.85 $\pm$ 5.53            | 0.68    |
| Total bilirubin ( $\mu$ mol/L)         | 19.47 $\pm$ 14.78          | 21.4 $\pm$ 13.15            | 0.54    |
| AFP (ng/mL)                            |                            |                             | 0.59    |
| $\leq$ 100                             | 82 (67.77%)                | 24 (72.73%)                 |         |
| $>$ 100                                | 39 (32.23%)                | 9 (27.27%)                  |         |
| CEA (ng/mL)                            |                            |                             | 0.47    |
| $>$ 5                                  | 4 (3.31%)                  | 2 (6.06%)                   |         |
| $\leq$ 5                               | 117 (96.69%)               | 31(93.94%)                  |         |
| CA125 (U/mL)                           |                            |                             | 0.54    |
| $>$ 24                                 | 20 (16.53%)                | 4 (12.12%)                  |         |
| $\leq$ 24                              | 101 (83.47%)               | 29 (87.88%)                 |         |
| CA199 (U/mL)                           |                            |                             | 0.60    |
| $>$ 25                                 | 35 (28.93%)                | 8(24.24%)                   |         |
| $\leq$ 25                              | 86 (71.07%)                | 25 (75.76%)                 |         |
| INR unit                               | 1.04 $\pm$ 0.11            | 1.07 $\pm$ 0.11             | 0.19    |
| ALT (IU/L)                             | 38.9 $\pm$ 41.03           | 43.39 $\pm$ 50.39           | 0.60    |
| AST (IU/L)                             | 45.17 $\pm$ 44.27          | 43 $\pm$ 49.3               | 0.28    |
| <b>HCC lesion features</b>             |                            |                             |         |
| Number of lesions                      | 124                        | 33                          |         |
| Size (cm)                              | 4.25 $\pm$ 3.46            | 3.87 $\pm$ 2.92             | 0.88    |

**Note:** Data are the mean  $\pm$  standard deviation or median and interquartile range (IQR) unless otherwise indicated. HCC: hepatocellular carcinoma; BMI: body mass index; AFP:  $\alpha$ -fetoprotein; CEA: carcinoembryonic antigen; CA125: carbohydrate antigen 125; CA199: Carbohydrate antigen 199; INR: international normalized ratio of prothrombin time; ALT: Alanine transaminase; AST: Aspartate transaminase.

\* Indicates statistically significant *p* values.

**Supplementary Table 3.** Mechanical parameters  $c$  (stiffness) and  $\phi$  (fluidity) of progenitor-type and non-progenitor-type HCC.

| Parameters   | Progenitor-type HCC<br>(n = 51) | Non-progenitor-type HCC<br>(n = 60) | <i>p</i> value |
|--------------|---------------------------------|-------------------------------------|----------------|
| <b>Tumor</b> |                                 |                                     |                |
| $c$ (m/s)    | $2.10 \pm 0.60$                 | $2.36 \pm 0.61$                     | 0.02*          |
| $\phi$ (rad) | $1.09 \pm 0.23$                 | $1.06 \pm 0.21$                     | 0.72           |
| <b>Liver</b> |                                 |                                     |                |
| $c$ (m/s)    | $1.93 \pm 0.41$                 | $2.06 \pm 0.43$                     | 0.11           |
| $\phi$ (rad) | $0.79 \pm 0.12$                 | $0.77 \pm 0.15$                     | 0.51           |

\* Indicates statistically significant  $p$  values.

**Supplementary Figure 1.** Bland-Altman plots of reader agreement. The  $c$  (a) and  $\phi$  (b) values of the tumor and  $c$  (c) and  $\phi$  (d) values of the liver.