Technical Advances in RFA of HCC

성균관의대 삼성서울병원
영상의학과 최동일
Non-surgical Therapy for HCC - 삼성서울병원 Protocol -

New (Initial) HCC

- Milan criteria
  - Yes
    - < 3 cm, ≤ 3
      - Planning US
        - Visible?
          - Yes
            - CEUS, AA or VNav
              - Feasible
              - Infeasible
            - SS-Combo
              - Single session TACE+RFA
            - DS-Combo
              - Dual session TACE+RFA
          - Equivocal / No
          - Infeasible
        - US-RFA
      - Infeasible
    - 3~5 cm, ≤ 3
      - Planning US
      - Feasible
      - Infeasible
  - No

Recurred HCC

- New
  - Planning US
  - Feasible
  - Infeasible
- LTP
  - Lipiodol?
    - No
    - Yes
    - Fluoro-RFA
US

• Most widely used guiding modality
  – Real-time control
  – Convenience
  – Relatively low cost
  – No radiation hazard
US-guided RFA for HCC

• Not all small HCCs are suitable for RFA
  – Very small HCCs
  – Subphrenic location
• Hard to detect on US

US-guided RFA for HCC

- Not all small HCCs are suitable for RFA
  - Very small HCCs
  - Subphrenic location
- Hard to detect on US

Advanced Liver cirrhosis

Explanted cirrhotic liver

US
Percutaneous RFA for HCC

• Small HCCs with poor conspicuity
  – Excluded from previous RFA studies

• Planning US
  – To determine if percutaneous RFA is feasible for the index tumor
  – 55% of patients
    • Feasible for percutaneous US-guided RFA
Unwanted events after RFA: Despite planning US

- **Residual tumor**
  - Partial coverage of the index tumor by the ablation zone

- **Mis-targeting**
  - No coverage of the index tumor by the ablation zone
Mis-targeting

Poor sonic window
Poor conspicuity

Planning US

After 1st RFA session

After 2nd RFA session

Lee MW, et al, JUM in press
Contrast enhanced harmonic US (CEUS)

• The Role of CEUS during RFA
  – Where are the lesions to be treated?
  – How many lesions are there?
  – Is there any viable residual tumor?
  – Any local recurrence?

CEUS-guided RFA:
Local tumor progression after TACE
Planning US: low echoic nodule
How does artificial ascites work?

- Sonic window
- Thermal injury
- Pain

Artificial ascites

Courtesy of pf. Rhim H
Artificial Ascites: Invisible HCC

1cm HCC

Post-RFA CT

Planning US

Artificial ascites
Artificial Ascites: Bowel protection

Pre-RFA

Post-RFA

Artificial ascites
Fusion Imaging (US + CT/MR)

- **Volume Navigation (GE)**
  - **Fusion**
    - US: real-time imaging
    - CT/MR: high quality images with good contrast and spatial resolution
  - **Navigate and track your position with GPS-like technology**

*Courtesy of Sally Lee*
Three Components

- Sensor
- Transmitter
- Fully integrated Position sensor unit

Courtesy of Sally Lee
How does volume navigation system work?

- **Uploading of CT/MR data to US machine**
  - **CT**
    - Arterial phase: *tumor* vs. *PV*
    - Portal phase: *tumor* vs. *PV*
  - **MR**
    - HBP (20 m): *tumor* vs. *PV*
- **Image fusion**
  - Plane registration
  - Point registration
Image Fusion

- **Plane registration**
  - **Portal vein**: anatomic landmark

Right Lobe: coronal

Left lobe: axial
Image Fusion

• **Point registration**
  – Tiny cyst or calcification in the liver
  – Point of vessel bifurcation
  – Index tumor
CT and MRI

Arterial

Delayed

Pre

MHV

9 mm

Art - Pre

3 m

HBP

T2WI
Planning US

<table>
<thead>
<tr>
<th>PATH</th>
<th>ORGAN</th>
<th>SIZE</th>
<th>CONSPICUITY</th>
<th>HS EFFECT</th>
<th>POSCH</th>
<th>F.CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MHV

Low echoic nodule?
Volume Navigation-guided RFA

T = Target

High echoic nodule
Fluoroscopic Guidance?

- Hybrid technique
  - Biplane fluoroscopy + US
  - HCC nodule with retained iodized oil
Biplane Fluoroscopic Guidance

Procedure time for initial placement < 1 min
Biplane fluoroscopy + US

- **Biplane fluoroscopic guidance**
  - Multiple overlapping (no microbubbles)
  - Low radiation dose
  - Oblique approach for dome HCC
  - HCC with faint lipiodol uptake
    - Poorly visible

- **Concurrent US guidance**
  - Appropriate skin entry site
  - To avoid traversing dangerous structure
  - US monitoring
    - To avoid collateral thermal damage.

Single session TACE + RFA
Single session TACE + RFA

1 day
1 month
4 months

Courtesy of pf. Cho SK
Dual session TACE + RFA

HCC with intermediate size (3-5cm)
RFA: 4 days after TACE

Total Ablation time: 36 m
#9 overlappings
Pre-RFA  

Post-RFA

“Sunny side up sign”

Technical success!
Non-surgical Therapy for HCC

- 삼성서울병원 Protocol -

New (Initial) HCC

Milan criteria

Yes

< 3 cm, ≤ 3
Planning US

Visible?

Yes

Equivocal / No

CEUS, AA or VNav

Feasible
Infeasible

US-RFA

SS-Combo

DS-Combo

TACEs

Recurred HCC

No

3~5 cm, ≤ 3
Planning US

> 5 cm, > 3
Planning US

New

LTP

Feasible

Infeasible

Lipiodol?

No

Yes

Fluoro-RFA

Non-surgical Therapy for HCC

- 삼성서울병원 Protocol -
Thank you for your attention