Radioembolization of liver metastases. A bridge to surgery

Fernando Pardo
Clínica Universidad de Navarra
Pamplona, Spain
Embolizing Particles for Intraarterial Therapy

<table>
<thead>
<tr>
<th></th>
<th>Resin</th>
<th>Glass</th>
</tr>
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<tbody>
<tr>
<td>Mean Diameter</td>
<td>35 µm</td>
<td>25 µm</td>
</tr>
<tr>
<td>Activity/sphere</td>
<td>50 Bq</td>
<td>2,500 Bq</td>
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</table>

Concept of Radioembolisation (RE-SIRT)

- To selectively target a very high radiation dose to all tumors within the liver, regardless of their cell of origin or location, while at the same time maintaining a low radiation dose to the normal liver tissue.

- Uses $^{90}$Yttrium-labelled microspheres
  - Diameter approx. 30 µm (microns)
  - Half life: 64 hours
  - Beta 0.93 MeV
  - Penetrates mean 2.5 mm tissue; max 11 mm
  - Achieves doses of 100–1,000+ Gy to tumor
RESIN ⁹⁰Y-MICROSPHERE BRACHYTHERAPY FOR UNRESECTABLE COLORECTAL LIVER METASTASES: MODERN USA EXPERIENCE

ANDREW S. KENNEDY, M.D., F.A.C.R.O.,* DOUGLAS COLDWELL, M.D.,† CHARLES NUTTING, D.O.,‡ RAVI MURTHY, M.D., F.A.C.P.,§ DANIEL E. WERTMAN, JR., M.D.,‖ STEPHEN P. LOEHR, M.D.,‖ CARROLL OVERTON, M.D.,‖ STEVEN MERANZE, M.D.,‡ JERRY NIEDZWIEKI, M.D.,** AND SCOTT SAILER, M.D.*

*Wake Radiology Oncology, Cary, NC; †Department of Radiology, University of Mississippi School of Medicine, Jackson, MS; ‡Department of Radiology, Good Samaritan Hospital, Phoenix, AZ; §Department of Radiology, Section of Interventional Radiology, The University of Texas M.D. Anderson Cancer Center, Houston, TX; ‖Department of Radiology, Durham Regional Hospital, Durham, NC; ‖Section of Interventional Radiology, Wake Radiology, Raleigh, NC; §Department of Radiology, Vanderbilt University School of Medicine, Nashville, TN; and **Department of Radiology, Section of Interventional Radiology, Tampa General Hospital, Tampa, FL

<table>
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<td>Rectum</td>
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<td>0 ± 0.8</td>
<td>0–4</td>
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<td>5.9% ± 3.4</td>
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<td>181</td>
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Fig. 2. Kaplan-Meier method calculation of survival from day of treatment to censure or death for 208 patients treated with resin $^{90}\text{Y}$ microspheres. The median survival for responders was 10.5 months vs. 4.5 months for nonresponding patients ($p = 0.0001$).
Radioembolization as a Salvage Therapy for Heavily Pretreated Patients With Colorectal Cancer Liver Metastases: Factors That Affect Outcomes

Constantinos T. Sofocleous,¹ Elena G. Violari,¹ Vlasis S. Sotirchos,¹ Waled Shady,¹ Mithat Gonen,² Neeta Pandit-Taskar,¹ Elena N. Petre,¹ Lynn A. Brody,¹ William Alago,¹ Richard K. Do,¹ Michael I. D’Angelica,³ Joseph R. Osborne,¹ Neil H. Segal,⁴ Jorge A. Carrasquillo,¹ Nancy E. Kemeny⁴
Phase I dose escalation study of SIRT + FOLFOX

Eligible Patients
• 20 first-line patients
• Chemotherapy naive
• Unresectable CRCLMs (liver dominant disease)
• ECOG PS 0 – 2

FOLFOX + SIR-Spheres
day 3 or 4 of cycle 1

Oxaliplatin dose escalated for first 3 cycles
• 30 mg/m²
• 60 mg/m²
• 85 mg/m²
…then 85 mg/m² from cycle 4 and beyond

Efficacy Endpoints

RR  PFS  OS
90%  9.2 mos  Not reported
14.2 mos (Liver only disease)
• The adverse event profile for all events other than Grade 3/4 neutropenia and Grade 1/2 abdominal pain is similar to the published outcomes for FOLFOX4

• Dose-limiting toxicity (DLT) is neutropenia

• Recommended maximum tolerated dose of oxaliplatin is 60 mg/m² for the first 3 cycles, with full FOLFOX doses thereafter

• Although the study is a small sample size, SIRT + FOLFOX produces impressive outcomes compared to FOLFOX alone
<table>
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<th>Study Name</th>
<th>Study Design</th>
<th>Geographic Region</th>
<th>Recruitment Completed</th>
<th>Patients Recruited</th>
<th>OS Data Expected</th>
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<td>FOXFIRE</td>
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<td>2017</td>
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<td>ANZ, AP, EME, US</td>
<td>January 2015</td>
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<td><strong>Total accrual</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>1,103</strong></td>
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</table>

1. ANZ: Australia, New Zealand; AP: Asia Pacific; EME: Europe & Middle East; UK: United Kingdom; US: United States
2. FOLFOX-based (+ biologic) vs. FOLFOX-based (+ biologic) + SIRT

SIRFLOX: Randomized phase III trial comparing first-line mFOLFOX6 (+bevacizumab) versus mFOLFOX6 (+bevacizumab) + selective internal radiation therapy (SIRT) in patients with metastatic colorectal cancer

- Peter Gibbs (1), Volker Heinemann, Navesh K. Sharma, Michael P. N. Findlay, Jens Ricke, Val Gebski, Mark Van Buskirk, Guy A. van Hazel, on behalf of the SIRFLOX Study Group

(1) The Royal Melbourne Hospital, Melbourne, Australia

Key Eligibility Criteria

- Adenocarcinoma of the colon or rectum
- Liver metastases not surgically resectable or ablatable (determined by local MDT)
- Limited extra-hepatic metastases allowed (protocol specific definition, by CT scan)
  - Up to 5 lung metastases ≤1 cm
  - Lymph nodes <2 cm in 1 anatomic region (chest, abdomen, or pelvis)
- WHO Performance Status 0 – 1
- No evidence of ascites, cirrhosis, portal hypertension, main portal vein tumor involvement or portal vein thrombosis
- No prior chemo except for adjuvant chemo completed ≥6 months prior
**Treatment Schedule**

**Control arm: mFOLFOX6 (+ bevacizumab) (1)**

<table>
<thead>
<tr>
<th>Cycle 1</th>
<th>Cycle 2</th>
<th>Cycle 3</th>
<th>Cycle ≥4</th>
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<tr>
<td>FOLFOX</td>
<td>FOLFOX</td>
<td>FOLFOX</td>
<td>FOLFOX</td>
</tr>
<tr>
<td>OX = 85 mg/m²</td>
<td>OX = 85 mg/m²</td>
<td>OX = 85 mg/m²</td>
<td>OX = 85 mg/m²</td>
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<tr>
<td>Bev</td>
<td>Bev</td>
<td>Bev</td>
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**Treatment arm: mFOLFOX6 (+ bevacizumab) (1) + SIRT (2)**

<table>
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<th>Preparation</th>
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<th>Cycle 2</th>
<th>Cycle 3</th>
<th>Cycle ≥4</th>
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<td>Work up for SIRT</td>
<td>FOLFOX</td>
<td>FOLFOX</td>
<td>FOLFOX</td>
<td>FOLFOX</td>
</tr>
<tr>
<td>On day -14 to -3</td>
<td>OX = 60 mg/m²</td>
<td>OX = 60 mg/m²</td>
<td>OX = 60 mg/m²</td>
<td>OX = 60 mg/m²</td>
</tr>
<tr>
<td>SIRT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On day 3 or 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Bevacizumab allowed at investigator’s discretion, per institutional practice.
2. Work-up procedure at Day (D) -14 to D-3 prior to SIRT; SIR-Spheres® Y-90 resin microspheres administered on either D3 or D4, of either Cycle 1 or Cycle 2.

Patients stratified to receive (bev) or not receive (no bev) treatment with bevacizumab, at the investigator’s discretion.

# Patient Characteristics in the ITT Population

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>FOLFOX (+ bev) (n = 263)</th>
<th>FOLFOX (+ bev) + SIRT (n = 267)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years, median (range)</td>
<td>63 (23 – 89)</td>
<td>63 (28 – 81)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>88 (34%)</td>
<td>85 (32%)</td>
</tr>
<tr>
<td>Male</td>
<td>174 (66%)</td>
<td>182 (68%)</td>
</tr>
<tr>
<td>WHO performance status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>175 (67%)</td>
<td>176 (66%)</td>
</tr>
<tr>
<td>1</td>
<td>87 (33%)</td>
<td>90 (34%)</td>
</tr>
<tr>
<td>Extra-hepatic metastases</td>
<td>104 (40%)</td>
<td>108 (40%)</td>
</tr>
<tr>
<td>Primary tumor not removed</td>
<td>121 (46%)</td>
<td>119 (45%)</td>
</tr>
<tr>
<td>Synchronous metastases</td>
<td>233 (89%)</td>
<td>241 (90%)</td>
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</table>

Progression-Free Survival at Any Site

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Events</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOLFOX (+ bev)</td>
<td>263</td>
<td>225</td>
<td>10.2 months</td>
</tr>
<tr>
<td>FOLFOX (+ bev) + SIRT</td>
<td>267</td>
<td>217</td>
<td>10.7 months</td>
</tr>
</tbody>
</table>

HR: 0.93 (95% CI: 0.77–1.12), \( p=0.43 \)

Progression-Free Survival in the Liver

- Median PFS in the liver:
  - FOLFOX (+ bev): 12.6 months
  - FOLFOX (+ bev) + SIRT: 20.5 months

- HR: 0.69 (95% CI: 0.55–0.90), p=0.002

- 7.9 month improvement in median PFS in the liver
- 31% reduction in risk of disease progression in the liver

Number at risk:
- FOLFOX: 263, 96, 29, 9, 5, 2
- FOLFOX + SIRT: 267, 106, 33, 11, 5, 2

315 treated by RE with glass microspheres

101 had single right lobe tumors

20 patients developed imaging findings of radiation lobectomy (marked ipsilateral lobar volume reduction and contralateral lobar volume increase)

First Case Report: PET/CT imaging

Baseline

4 weeks post first SIRT

3 months post second SIRT

Gulec SA et al. WJSO 2009; 7: 6
First Case Report: intra-operative observations

Atrophied right lobe with down-sized tumour / scarring

2.7x hypertrophy of the left lobe

Gulec SA et al. WJSO 2009; 7: 6
Volumetric Changes after $^{90}$Y Radioembolization for Hepatocellular Carcinoma in Cirrhosis: An Option to Portal Vein Embolization in a Preoperative Setting?

Julien Edeline, MD$^{1,2,3}$, Laurence Lenoir, MD$^{2,3,4}$, Karim Boudjema, MD, PhD$^{3,5}$, Yan Rolland, MD$^{2,6}$, Anne Boulic$^{7}$, Fanny Le Du$^{1}$, Marc Pracht, MD$^{1,2}$, Jean-Luc Raoul, MD, PhD$^{8}$, Bruno Clément, PhD$^{2}$, Étienne Garin, MD, PhD$^{2,3,4}$, and Eveline Boucher, MD$^{1}$

### Liver Volumes

<table>
<thead>
<tr>
<th></th>
<th>Basal (n=35)</th>
<th>3 months (n=28)</th>
<th>Maximum (n=35)</th>
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</thead>
<tbody>
<tr>
<td>Treated Lobe (ml)</td>
<td>1038</td>
<td>838</td>
<td>794</td>
</tr>
<tr>
<td>Untreated Lobe (ml)</td>
<td>734</td>
<td>953</td>
<td>955</td>
</tr>
</tbody>
</table>

Ann Surg Oncol 2013
Partial liver volume radioembolization induces hypertrophy in the spared hemiliver and no major signs of portal hypertension

Nerea Fernández-Ros*, Nuno Silva*, Jose Ignacio Bilbao2,5, Mercedes Iñarrairaegui1,5,6, Alberto Benito2,5, Delia D'Avola1,6, Macarena Rodriguez5,3, Fernando Rotellar5,4, Fernando Pardo5,4 & Bruno Sangro1,5,6

- 83 pts with HCC (63%), metastastic tumors (32%) or ICC (5%).
- Median Age: 66 years
- Cirrhosis: 53%
- Median platelet count: 163x10⁹/L
- Median total bilirubin: 0.92 mg/dL
- Portal vein thrombosis: 8.4%
- Treated Lobe: 79.5% right / 20.5% left
• Liver volume

* p < 0.001

• Independent of treated lobe

• Even when patients with contralateral progression were excluded

• No significant changes in total liver volume
Safety of Hepatic Resection in Metastatic Disease to the Liver After Yttrium-90 Therapy

Ryan Whitney, B.S., Cliff Tatum, M.D., Mike Hahl, M.D., Susan Ellis, R.N., Charles R. Scoggins, M.D., M.B.A., Kelly McMasters, M.D., Ph.D., and Robert C. G. Martin, M.D., Ph.D.1

Division of Surgical Oncology, Department of Surgery, University of Louisville School of Medicine, Louisville, Kentucky

Journal of Surgical Research 166, 236–240 (2011)

Hepatectomy after hepatic arterial therapy with either yttrium-90 or drug-eluting bead chemotherapy: is it safe?

Russell E. Brown1, Matthew R. Bower1, Tiffany L. Metzger1, Charles R. Scoggins1, Kelly M. McMasters1, Michael J. Hahl2, Cliff Tatum3 & Robert C.G. Martin1

1Division of Surgical Oncology, Department of Surgery, University of Louisville, 2Department of Radiation Oncology, Norton Cancer Institute, and 3Department of Radiology, Norton Healthcare, Louisville, KY, USA

HPB 2011, 13, 91–95

Response to radioembolization with yttrium-90 resin microspheres may allow surgical treatment with curative intent and prolonged survival in previously unresectable hepatocellular carcinoma

M. Iñarrairaegui a,b,*, F. Pardo c, J.I. Bilbao d, F. Rotellar c, A. Benito d, D. D’Avola a,b, J.I. Herrero a,b, M. Rodriguez e, P. Martí c, G. Zozaya c, I. Dominguez e, J. Quiroga a,b, B. Sangro a,b

a Liver Unit, Clinica Universidad de Navarra, Pamplona, Spain
b Centro de Investigacion Biomédica en Red de Enfermedades Hepáticas y Digestivas (CIBERehd), Spain
c Department of Surgery, Clinica Universidad de Navarra, Pamplona, Spain
d Department of Radiology, Clinica Universidad de Navarra, Pamplona, Spain
e Department of Nuclear Medicine, Clinica Universidad de Navarra, Pamplona, Spain

EJSO 38 (2012) 594-601
The Post-SIR-Spheres Surgery Study (P4S): Analysis of Outcomes following Hepatic Resection or Transplantation in 100 Patients Previously Treated with Selective Internal Radiation Therapy (SIRT)

Fernando Pardo,1 Michael Schön,2 Rheun-Chuan Lee,3 Derek Manas,4,5 Rohan Jeyarajah,6 Georgios Katsanos,7 Geert Maleux,8 Bruno Sangro.9

1. HPB and Transplant Surgery, Clínica Universidad de Navarra, Pamplona, Navarra, Spain; 2. Klinikum Karlsruhe, Karlsruhe, Germany; 3. Radiology, Taipei Veterans General Hospital and National Yang-Ming University School of Medicine, Taipei, Taiwan; 4. Institute of Transplantation, University of Newcastle Upon Tyne, Newcastle Upon Tyne, United Kingdom; 5. Newcastle NHS Trust, Newcastle Upon Tyne, United Kingdom; 6. Surgical Oncology, Methodist Dallas Medical Center, Dallas, TX, United States; 7. Hepatobiliary and Transplant Surgery, Hôpital Erasme & Institut Jules Bordet, Brussels, Belgium; 8. Interventional Radiology, UZ Gasthuisberg, Leuven, Belgium; 9. Liver Unit, Clinica Universidad de Navarra and Centro de Investigacion Biomedica en Red de Enfermedades Hepaticas y Digestivas (CIBEREHD), Pamplona, Navarra, Spain.
# P4S Study

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<th>PI</th>
<th>Entered Patients</th>
<th>Clean patients</th>
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<td></td>
<td></td>
<td></td>
<td><strong>32</strong></td>
<td><strong>23</strong></td>
</tr>
</tbody>
</table>

**Total** 111 100
Major, but not Extended, Resection
[3–4 segments resected] (n = 32)

Major Resection
[≥3 segments resected] (n = 51)

Minor Resection
[1–2 segments resected] (n = 20)

Extended Resection
[≥5 segments resected] (n = 19)

Transplanted Organ

Number of Segments Resected

1 2 3 4 5 6

Liver Resection
(n = 71)

Unresectable Liver Tumours
(n = 100)

SIR using SIR-Spheres 90Y resin microspheres ± other therapies

Registered and Assessed for Eligibility
(n = 114)

Surgery performed August 1998 to May 2014

Liver Transplantation
(n = 29)

Excluded from analysis (n = 14)
- Insufficient mandatory data (n = 9)
- No liver surgery (n = 2)
- No SIRT (n = 1)
- <90 days follow-up (n = 1)
- Transplant post-resection † (n = 1)

† included in resection sub-group only

± prior treatment

Excluded from analysis (n = 14)
- Insufficient mandatory data (n = 9)
- No liver surgery (n = 2)
- No SIRT (n = 1)
- <90 days follow-up (n = 1)
- Transplant post-resection † (n = 1)

† included in resection sub-group only

Excluded from analysis (n = 14)
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Registered and Assessed for Eligibility (n = 114)

Unresectable Liver Tumours (n = 100)

± prior treatment

SIR using SIR-Spheres 90Y resin microspheres ± other therapies

Liver Resection (n = 71)

Surgery performed August 1998 to May 2014

Liver Transplantation (n = 29)

Excluded from analysis (n = 14)
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- No liver surgery (n = 2)
- No SIRT (n = 1)
- <90 days follow-up (n = 1)
- Transplant post-resection † (n = 1)

† included in resection sub-group only

Registered and Assessed for Eligibility (n = 114)

Unresectable Liver Tumours (n = 100)

± prior treatment

SIR using SIR-Spheres 90Y resin microspheres ± other therapies

Liver Resection (n = 71)

Surgery performed August 1998 to May 2014

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Liver Transplantation (n = 29)
Baseline Characteristics: Disease

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Liver Resection (N = 71)</th>
<th>Liver Transplant (N = 29)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tumour type: HCC</td>
<td>23 (32.4%)</td>
<td>26 (89.7%)</td>
</tr>
<tr>
<td>Colorectal cancer</td>
<td>30 (42.3%)</td>
<td>0</td>
</tr>
<tr>
<td>Cholangiocarcinoma</td>
<td>7 (9.9%)</td>
<td>0</td>
</tr>
<tr>
<td>Neuroendocrine tumour</td>
<td>4 (5.6%)</td>
<td>3 (10.3%)</td>
</tr>
<tr>
<td>Other</td>
<td>7 (9.9%)</td>
<td>0</td>
</tr>
<tr>
<td>Bilobar distribution</td>
<td>31 (43.7%)</td>
<td>13 (44.8%)</td>
</tr>
<tr>
<td>Primary tumour <em>in situ</em> (in non-HCC):</td>
<td>21 (44.7%) (^i)</td>
<td>3 (10.3%)</td>
</tr>
<tr>
<td>Cirrhosis:</td>
<td>16 (22.5%) (^iii)</td>
<td>25 (86.2%) (^i)</td>
</tr>
</tbody>
</table>
SIRT Prior to Surgery

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Liver Resection (N = 71)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minor (N = 20)</td>
<td>Major, Not</td>
<td>Extended (N = 19)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Extended</td>
<td></td>
</tr>
<tr>
<td>Intent of SIRT:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Down-sizing</td>
<td>15 (75.0%)</td>
<td>23 (71.9%)</td>
<td>15 (78.9%)</td>
</tr>
<tr>
<td>Palliative</td>
<td>5 (25.0%)</td>
<td>5 (15.6%)</td>
<td>0</td>
</tr>
<tr>
<td>Unknown</td>
<td>0</td>
<td>3 (9.4%)</td>
<td>4 (21.1%)</td>
</tr>
<tr>
<td>No. of SIRT procedures:</td>
<td>1</td>
<td>26 (81.3%)</td>
<td>14 (73.7%)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5 (15.6%)</td>
<td>5 (26.3%)</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1 (3.1%)</td>
<td>0</td>
</tr>
<tr>
<td>SIRT to whole liver:</td>
<td>9 (45.0%)</td>
<td>9 (28.1%)</td>
<td>4 (21.1%)</td>
</tr>
<tr>
<td>Median total SIRT activity (IQR) [range], GBq :</td>
<td>1.4 (0.7) [0.1 – 2.9]</td>
<td>1.5 (1.0) [0.3 – 5.0]</td>
<td>1.7 (0.9) [0.6 – 3.0]</td>
</tr>
</tbody>
</table>

Percentages calculated on available data; n (%) unless stated; SIRT: Selective Internal Radiation Therapy.
## Surgical Procedure

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Liver Resection (N = 71)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minor (N = 20)</td>
</tr>
<tr>
<td>Resection extent:</td>
<td></td>
</tr>
<tr>
<td>2-stage non-ALPPS procedure</td>
<td>0</td>
</tr>
<tr>
<td>2-stage ALPPS procedure</td>
<td>0</td>
</tr>
<tr>
<td>Additional tumorectomies:</td>
<td>2 (10.0%)</td>
</tr>
<tr>
<td>Additional ablation:</td>
<td>5 (25.0%)</td>
</tr>
<tr>
<td>Resection margin: R0</td>
<td>15 (75.0%)</td>
</tr>
<tr>
<td>R1</td>
<td>5 (25.0%)</td>
</tr>
<tr>
<td>R2</td>
<td>0</td>
</tr>
</tbody>
</table>

N (%) unless stated; ALPPS: Associating Liver Partition and Portal vein ligation for Staged hepatectomy; na: not applicable.
## Outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Liver Resection (N = 71)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minor (N = 20)</td>
</tr>
<tr>
<td>Median (IQR) duration to hospital discharge, days:</td>
<td>7.5 (4.0)</td>
</tr>
<tr>
<td>90-day readmission rate:</td>
<td>4 (20.0%)</td>
</tr>
<tr>
<td>All-cause mortality at:</td>
<td></td>
</tr>
<tr>
<td>30 days</td>
<td>0</td>
</tr>
<tr>
<td>90 days</td>
<td>0</td>
</tr>
<tr>
<td>P-values stated comparing minor vs. major not-extended vs. extended resection Fisher’s exact test (2x2 table).</td>
<td></td>
</tr>
<tr>
<td>Median follow-up from:</td>
<td></td>
</tr>
<tr>
<td>1st SIRT Surgery</td>
<td>28.5 months</td>
</tr>
<tr>
<td>Surgery</td>
<td>37.4 months</td>
</tr>
</tbody>
</table>

N (%) unless stated; missing baseline data on 1 patient; 95% CI: 95% confidence interval; nc: not calculable;
Analysis of 90-Day All-Cause Mortality

- Cumulative 90-day all-cause mortality from first hepatic surgery was 4 (4% overall; 6% of resected patients)

- These 4 cases were all trisectionectomies
  - Comprised 3 metastatic colorectal cancer; 1 cholangiocarcinoma
  - Typically these cases had ≥1 prior chemotherapy line, pre-surgical co-morbidities and/or other risk factors, and suffered post-hepatectomy multi-organ failure including liver failure

- Future liver remnant was targeted with SIRT in 1 of the 4 cases and received some activity in another case

- No deaths appear to be directly related to SIRT
Conclusions

• The safety profile of post-SIRT resection appears in line with published studies of hepatic resection

• The addition of SIRT to first-line chemotherapy improves PFS in the liver (31% reduction in risk of disease progression in the liver)

• SIRT could improve resection rate of liver metastases