# Colorectal Liver Metastasis Survival After Yittrium-90 Radioembolization: A Complete 3-year Experience

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**Abstract**

Background: The role and benefit of yittrium-90 (Y-90) remain in question amongst patients with metastatic chemo-refractory colorectal liver metastases (CRLM). We aim to report a complete experience and outcomes following lobar, segmental, combination administration, and repeated Y-90 radioembolizations utilizing a minimal prescribed dose in the treatment of CRLM. Methods and Results: This is a retrospective analysis of all patients who underwent Y-90 radioembolization of CRLM at a single institution. Tumor response was evaluated using a modified RECIST criteria 2-6 months post-radioembolization. Progression-free survival (PFS) was the primary outcome of interest. Tumor response, conversion to resectable disease, and overall survival (OS) were analyzed as a secondary outcomes. 4 rectal and 7 colonic adenocarcinoma CRLM patients with significant previous systemic therapy exposure were included. The median tumor number and size was 3 and 4.0 cm, respectively. 7 segmental and 12 lobar radioembolizations were performed (range 1-6 per patient) with a mean administered activity of 22.1 mCi. Tumor regression occurred in 71.4% of cases with 4 complete radiographic responses. The median hepatic PFS was 5.5 months. The median OS from the time of primary cancer diagnosis and initial Y-90 was 3.2 and 1.2 years, respectively. 18% of initially unresectable patients were converted to surgically resectable. Conclusions: Y-90 results in reliable tumor regression and repeated radioembolizations are safe when conservative doses are utilized in a multidisciplinary setting. This study supports the 'neoadjuvant' use of Y-90 to allow for the conversion of borderline resectable patients to resectable. The results suggest that Y-90 maybe associated with an OS benefit in chem-refractory CRLM patients.

*Title Page*

**Complete title:** Colorectal Liver Metastasis Survival After Yittrium-90 Radioembolization: A Complete 3-year Experience

**Short title:** Y-90 Colorectal Liver Metastasis Survival

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**Aim:** To report a complete experience and outcomes following lobar, segmental, combination administration, and repeated Y-90 radioembolizations utilizing a minimal prescribed dose in the treatment of CRLM.

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**Conclusions:** Y-90 results in reliable tumor regression and repeated radioembolizations are safe when conservative doses are utilized in a multidisciplinary setting. This study supports the 'neoadjuvant' use of Y-90 to allow for the conversion of borderline resectable patients to resectable. The results suggest that Y-90 maybe associated with an OS benefit in chem-refractory CRLM patients.

**Keywords:** metastatic colorectal cancer, selective internal radiation therapy (SIRT), yttrium-90 (Y-90), hepatic progression-free survival (PFS), overall survival (OS)

**Practitioner Points:**

- Y-90 provides reliable hepatic colorectal tumor regression and may act as a bridge to metastasectomy.
- Y-90 appears to be safe amongst highly pre-treated patients.
- A survival benefit may exist when Y-90 is utilized after first line treatment modalities.

***Manuscript***

## Introduction

Colorectal cancer was the second leading cause of cancer related death in the United States in 2022, but only accounted for 7.9% of new cancer diagnoses [1]. While the incidence of colorectal cancer has steadily declined since the early 1990's with improved prevention techniques, the associated improvement in mortality rate has been more modest despite advances in early cancer detection capabilities, imaging quality, surgical technique, and systemic therapies [1]. Illustrating this, metastatic disease has been consistently identified in about 20% of new colorectal cancer diagnoses between 2004 and 2018. During that same time period, patients with stage IV disease only saw an estimated 4.2% increase in 5-year relative survival [2].

Unfortunately, 14.5% of patients present with synchronous hepatic metastases and 30.4% of those with stage III disease will develop metachronous lesions within 5 years [3]. Hepatic metastases can be difficult to treat, which is likely why they remain responsible for up to two-thirds of colorectal cancer associated mortality. Aggressive metastasectomy remains the gold standard of treatment due to its proven survival benefit, but only 20% of patients with hepatic metastasis are candidates for resection. As a result, multiple second-line procedural therapies have been developed to assist in the management of these lesions: thermal ablation, trans-arterial bland- or chemo-embolization (TACE), selective internal radiation therapy (SIRT) with yttrium-90 (Y-90), among others [4].

SIRT, also known as radioembolization, is an arterial-based therapy that delivers beta radionuclide emitting Y-90-labeled resin microspheres (SIR-Spheres?, SirTex Medical Limited, Sydney, Australia) directly to the tumor microvasculature resulting in tumor embolization and radiation induced fibrosis. In theory, the small

diameter of SIR-Spheres[?], relative to other available bead therapies, allows for a more tumor targeted treatment with less destruction of healthy hepatic tissue [5].

A combined analysis of the FOXFIRE, SIRFLOX, and FOXFIRE-Global, prospective randomized trials of chemotherapy naïve patients with limited metastatic disease, identified an increased tumor response and improved hepatic progression-free survival (PFS) with Y-90 plus FOLFOX over FOLFOX alone. Importantly, these trials did not identify an overall survival (OS) benefit associated with Y-90 use [6]. Although some small prospective studies have identified survival benefits based on tumor response to Y-90 radioembolization, questions remain regarding the validity these findings [7–9].

The purpose of this retrospective study was to report the method of utilization and administration, tumor response, and patient outcomes following Y-90 radioembolizations in heavily pre-treated patients with hepatic colorectal cancer metastasis within a community practice setting.

## Materials and Methods

All patients from a single institution with colorectal liver metastasis (CRLM) treated with Y-90 resin microspheres between February 2019 and April 2022 were included in this retrospective analysis. All patients were considered borderline resectable, unresectable, or were not candidates for operative resection due to comorbidities at the time of referral for Y-90. This institution utilizes an interdisciplinary tumor board in the management of patients with malignancy in accordance with current recommendations. Study approval was granted by the institutional review board and informed consent was waived due to its retrospective nature.

### *Data Collection*

Treatments were performed on an outpatient basis as a partnership between a private surgical and interventional radiology group in concordance with multiple medical oncology teams. The surgical team was the primary coordinator of care for these patients and clinical documentation between providers was freely exchanged during the course of treatment. Data pertaining to the dates of diagnoses, pathology results, stage at diagnosis, number and type of systemic therapy regimens, previous procedural interventions, and treatment associated toxicities were obtained by chart review. The date the patient was last known to be alive was derived from the last known medical appointment the patient attended while the date of death was obtained from chart and public records review.

Prior to intervention with Y-90 cross-sectional imaging was obtained of the chest, abdomen, and pelvis using triple-phase computed tomography (CT) or magnetic resonance imaging (MRI). Cross-sectional imaging was repeated 2-6 months after Y-90 radioembolization with a preference for 3 months. While patients often received imaging via multiple modalities in the post-treatment window, efforts were made to select the imaging closest to 3 months post-treatment that was of the same modality as the pre-treatment imaging.

Data regarding the pre- and post-treatment dominant hepatic tumor size, number of hepatic tumors, and locations of disease were obtained from the analogous radiology report and used in determination of tumor response. During the follow-up period all available CT, MRI, and positron emission tomography (PET) scans and documentation from other providers were evaluated for growth of known lesions treated with Y-90 or development of new areas of hepatic metastasis.

### *Initial Tumor Response*

Determination of initial tumor response was based on a modified Response Evaluation Criteria in Solid Tumors (RECIST) method [10]. All tumor measurements were based on the maximal tumor diameter of that lesion. Patients were considered to have a complete response if there was no longer radiographically identified tumor in the treatment field. Where possible, this finding was confirmed with the resolution of diffusion restriction on MRI and with PET scan.

Progression of disease, in relation to initial treatment response, was defined by a [?]20% increase in any treated hepatic tumor diameter or the development of previously unseen metastatic lesions in a segment treated by Y-90. A decrease of <30% or an increase of <20% in the dominant hepatic tumor diameter, with

no more than a 20% increase any smaller hepatic metastases, and no new lesions in the treatment field were classified as stable disease. Partial tumor response was based on the identification of no new tumors in the treatment field in addition to one of the following:

- [?]30% decrease in tumor diameter in patients with a single lesion,
- [?]30% decrease in the dominant tumor diameter with at least stability of any smaller metastases, or
- A decrease in the number of visible hepatic metastases with partial regression or stability of the remaining tumors.

*Y-90 Radioembolizations*

Patients were not candidates for Y-90 if they demonstrated a poor performance status with an Eastern Cooperative Oncology Group (ECOG) performance status score $> 2$, exhibited abdominal ascites, or had a total bilirubin level >3.0 mg/dL.

All patients underwent an assessment with visceral arterial angiogram with coil embolization(s) of the gastroduodenal artery, right gastric artery, and supraduodenal artery as needed. A technetium-99m macroaggregated albumin (Tc-99m MAA) shunt study was obtained prior to therapeutic Y-90 intervention. The Y-90 microsphere dose was calculated based on the patient's height, patient weight, hepatic volume of the planned treatment area, and the estimated percent tumor involvement. This is commonly known as the body surface area (BSA) method. Doses were modified based on elevated shunt fractions, extent of prior chemotherapy, and patient performance status.

*Definitions*

We utilize the definitions put forth by Jeyarajah et al. surrounding resectable, borderline resectable, and unresectable disease [5].

'Specific' Y-90 radioembolizations refers to cannulation of different hepatic arteries for the intended purpose of treating a different hepatic segment or lobe. These may occur on the same or different days, but were pre-specified in the treatment course. 'Complete therapeutic' Y-90 intervention refers to all of the planned specific Y-90 radioembolizations performed in a treatment course. Patients may have more than 1 complete therapeutic intervention if they were followed after their initial pre-specified treatment course, re-imaged, and the decision was made to perform repeated Y-90 radioembolization.

Hepatic PFS was calculated from the time of initial Y-90 administration until the first radiographic evidence of any new hepatic disease or progression of previously Y-90 treated tumors. OS was calculated from the date of first colorectal cancer diagnosis to the date of death in deceased patients or the date of last known medical contact among censored patients. OS after Y-90, or Y-90 specific survival, was obtained from the date of initial therapeutic Y-90 administration to the date of death or last known medical contact.

*Statistical Analysis*

11 patients representing 14 complete therapeutic Y-90 interventions were identified and included in the analysis. The additional data obtained from 2 patients who underwent >1 complete therapeutic Y-90 radioembolization were included the initial tumor response to treatment, dominant hepatic diameter, number of hepatic tumors, exposure to systemic therapies, administered Y-90 activity, and type of progression analyses. In 1 case, pre- and post-treatment tumor measurements were not compared due to incongruent imaging modalities within the specified treatment window.

Data were assessed and found to be non-parametric. Continuous variables were presented as the median and associated interquartile range (IQR). Categorical variables were presented as the frequency and representative percentage. A limited analysis of differences between groups were completed using the Mann-Whitney $U$ test and Wilcoxon signed rank test. The Kaplan-Meier method was used to calculate the median OS and its 95% confidence interval (95% CI). A two-tailed P-value $<0.05$ was considered statistically significant. All data analyses were performed using SPSS for Macintosh, Version 28.0 (IBM Corp. Released 2021. Armonk, NY, USA).

## Results

11 patients identified patients underwent a total of 19 specific Y-90 radioembolizations, accounting for 14 complete therapeutic Y-90 interventions.

*Participants*

Table 1 displays relevant patient and tumor characteristics. The median age was 61 (IQR 23) years at the time of Y-90. 4 (36.4%) patients had rectal adenocarcinoma while 7 (63.6%) were diagnosed with colonic adenocarcinoma, of which right-sided was the most common. 7 patients were stage IV at the time of diagnosis with 5 (45.5%) having synchronous hepatic lesions. Among those with metachronous hepatic metastasis, the median time to hepatic disease was 15 (IQR 6) months from the primary diagnosis. Multiple hepatic tumors were common at the time of Y-90 intervention, with the median being 3 (range 1-innumerable) tumors.

*Previous Therapies*

Prior to Y-90, 8 (72.7%) patients had previously undergone resection of their primary malignancy. 4 (36.4%) patients had a prior hepatectomy and 4 (36.4%) previously underwent ablation therapy. 6 (54.5%) patients had no previous liver specific therapy.

There were significant systemic therapy exposures within the population. 57.1% had been exposed to 3 or more chemotherapy lines (capecitabine, oxaliplatin, irinotecan, 5-fluorouracil) and all but 1 patient had been placed on at least 1 biologic agent (bevacizumab, cetuximab, panitumumab) prior to Y-90 (Table 2).

*Y-90 Radioembolization*

The median time from identification of hepatic metastasis to initial Y-90 radioembolization was 13.6 (IQR 14.9) months. Of the 19 specific radioembolizations performed, 7 were non-selective lobar treatments (7 right lobe, 5 left lobe) while 7 were selective segmental (6 segment IV, 1 segment II) administrations. The median administered activity by treatment location are detailed in Table 3. The prescribed activity was the administered activity in 100% of cases.

1 patient underwent sequential lobar radioembolizations, separated by 34 days, to achieve whole liver therapy. 7 lobar administrations occurred in isolation while 3 were combined with a single segment radioembolization. Of those 3 combined cases, 2 were performed in a single day. 1 patient received simultaneous selective radioembolization to two segments. 2 selective segmental treatments occurred in isolation.

2 patients (Patient A and B) underwent >1 complete therapeutic Y-90 radioembolization. Together these patients accounted for 8 discrete Y-90 radioembolizations, accounting for 5 total therapeutic interventions. The median time from identified post-treatment hepatic disease progression to the subsequent Y-90 radioemboization was 39 (range 31-52) days. Patient A underwent therapeutic interventions to the left lobe with simultaneous segment IV treatment twice and simultaneous segment II with segment IV once over the course of 15 months. Patient B had two radioembolizations of the same hepatic lobe separated by 16 months.

*Outcomes*

Of the 14 complete treatments, 10 (71.4%) saw regression of hepatic tumors of which 4 (28.6%) resulted in a complete radiographic response of the treated lesion(s). 4 patients met criteria for initial progression of hepatic disease. 3 were a result of >20% increase in treated lesions while 1 developed new hepatic disease in the treatment area while the previously treated lesion remained stable.

Overall tumor response to Y-90 is shown in Table 3. Analysis of patients exhibiting a complete or partial initial tumor response resulted in a median dominant tumor size decrease to 3.1 (IQR 7.7) from 4.1 (IQR 6.0) cm. In this same population, the median number of hepatic tumors decreased to 1 (range: 1-innumerable) from 3 (range: 1-innumerable).

All patients eventually experienced progression of hepatic disease after Y-90 radioembolization during the follow-up period. Overall, the median hepatic PFS was 5.5 (IQR 5.5) months. In 4 (28.6%) cases this was

secondary to the development of new hepatic metastases, 5 (35.7%) were a result of growth of previously treated lesions, and the remaining 5 were a combination of both new tumors and progression of existing disease (Table 3). Remarkably, the median hepatic PFS of patients demonstrating tumor regression was nearly twice that of those found to have stable or progressive hepatic disease after Y-90 (6.2 (IQR 4.8) months vs 3.5 (IQR 6.3) months, P=0.304).

Based on Kaplan-Meier analysis, the median OS of the entire cohort (N=11) was 5.2 years (Figure 1) while the Y-90 specific survival was 2.3 years (95% CI 0.3, 4.2) (Figure 2). From the time of diagnosis, the 1-year, 3-year, and 5-year survival were 100%, 72.7% (1 censored), and 18.2% (5 censored), respectively. The 1-year survival after initial Y-90 administration was 63.5% (2 patients censored). 5 (45.5%) of the study patients have died. For these 5 patients, the median OS and OS after Y-90 radioembolization was 3.1 (IQR 2.5) years and 1.2 (IQR 2.1) years, respectively. 6 (54.5%) patients remain alive at the time of this study with a median follow-up of 1.6 (range 0.5-2.3) years since Y-90.

2 (18.2%) borderline resectable patients were offered hepatic resection after Y-90. 1 of these patients elected for resection. There were no complications with postoperative hepatic remnant function.

*Adverse Events*

Complete data regarding full clinical side effects are unavailable, although mild abdominal pain and nausea were commonly documented. Pre- and post-treatment liver function test (LFT) values were available for 7 (50%) Y-90 interventions. Of those, 3 with previously normal LFTs developed elevated lab values. Due to the variation in different laboratories' normal value ranges, comparisons of pre- and post-treatment LFTs are not reported. No patient was known to have developed hyperbilirubinemia. Additionally, there were no reported internal or access site hemorrhage related complications. 1 patient developed severe abdominal pain several days after Y-90, but was found to have no identifiable abnormalities on upper endoscopy or cross-sectional imaging. This pain was intermittent and self-resolved. A second patient developed recurrent abdominal ascites requiring repeated paracentesis after contralateral lobar and selective segmental radioembolizations.

**Discussion**

This study demonstrated Y-90-associated hepatic tumor regression and improved hepatic PFS remain true even in heavily pre-treated and disease burdened patients. Our unique combination of two private practices makes this study distinct and maybe more reflective of what is occurring in "real life" outside of academic medical centers. Additionally, the data suggests an OS benefit amongst these patients when compared to historical controls. Finally, these results support the safety of Y-90 use in patients with previous hepatic resection, significant hepatotoxic chemotherapy exposure, and previous Y-90 administrations when appropriate dose reductions are made.

71.4% of Y-90 radioembolizations resulted in tumor regression with a median reduction of 1.5 cm in the dominant lesion and the radiographic disappearance of 2 tumors, amongst responders. 28.6% of treatments results in a complete radiographic response of tumors within the treatment field. Together these results allowed for 2 patients to be offered surgical resection of their hepatic metastases. This is notably different than the findings of previous large, prospective clinical trials that did not identify Y-90 to be significantly better than chemotherapy alone in the rate of conversion to resectable liver disease [6].

Importantly, these trials were performed in healthy patients (ECOG <2), who were chemotherapy naive, had minimal metastatic tumor burden, and utilized Y-90 as a first-line therapy. There is the possibility that in populations with significant chemotherapy exposure and progressive disease while on systemic therapy, that Y-90's role in conversion of borderline patients maybe more significant, as suggested by the results of this study.

It is known that even with hepatic metastectomy, 60-70% of patients will develop disease recurrence, often within 2 years of resection [11]. In borderline resectable CRLM patients with limited extrahepatic disease, Y-90 control of the hepatic lesion allows for a chemotherapy holiday which simulates the perioperative window where chemotherapy will not be used and early hepatic and distant recurrences are often seen. This provides

treatment teams with a chance to evaluate the patent's specific tumor biology. From this, better informed discussions with the patient can be had about their risk of recurrence after hepatic resection. Ultimately, this may result in reduced resection-associated morbidity for some patients with seemingly more aggressive tumor biology for whom early recurrence can be anticipated.

The overall median hepatic PFS was 5.5 months after Y-90, and was longer for radiographic responders than those with stable or progressive disease (6.2 vs. 3.5 months). All patients eventually had progression of hepatic disease. It was not uncommon for this to occur at the site of previous tumor regression, including among those with a complete radiographic response, indicating the likelihood that microscopic disease remained present. This highlights the need for both improvement in current radiographic capabilities and the need for operative resection of sites of previous sites of malignancy, despite lack of visible disease, when possible.

Despite the eventual hepatic disease progression, this cohort exhibited an OS of 62.4 months, which is much longer than would be expected based on their stage at diagnosis and current disease burden. According to the SEER database (2012-2018), the 3-year relative survival was 24.3% among stage IV at diagnosis patients [2]. In this study, amongst stage IV at diagnosis patients, the 3-year survival was 71.4%. The median survival since Y-90 administration was 2.3 years (27.6 months). This is an improvement over the 22.6 months identified when Y-90 was used as a first-line therapy and many studies with liver dominant or liver only disease [6, 9]. These results indicate that participants of this study are surviving longer than their historical control counterparts based on diagnosis at stage and compared to those with earlier Y-90 utilization.

Finally, these results support the available literature regarding the general safety of Y-90 use. Despite multiple complete radioembolizations in the same patients, previous hepatic resections, and a heavily pre-treated population there was only 1 significant complication involving recurrent ascites. Importantly, this patient also had a large tumor overlying his right hepatic vein, had undergone 14 cycles of chemotherapy prior to Y-90, and had undergone a contralateral lobar with selective segmental Y-90 radioembolizations. Ultimately, no patient developed significant hyperbilirubinemia. We attribute the overall very low serious complication rate to our utilization of a lower prescribed dose than is available in most published literature.

*Limitations*

There are multiple limitations to this study. There is undoubtedly unaccounted for bias in which patients received Y-90 and which did not. It is common in our practice to refer for Y-90 in most patients who are not resectable at presentation. Failure to undergo Y-90 in this setting was most commonly a result of patient preference, inability to tolerate the treatment, or the patient was lost to follow-up. The small size prevents significant statistical assessment of the impact of the various factors on survival, including specific systemic therapy regimens and additional procedural interventions. Finally, while the community-based nature of this study is primarily seen as a benefit, it does likely have some bearing on patient outcomes. Largely, our patients are privately insured which potentially grants them access to medical care and implicit lifestyle benefits not afforded to all patients of academic institutions.

## Conclusions

This is the first study of its kind to demonstrate significant hepatic tumor regression in metastatic, heavily pre-treated colorectal cancer patients in a community-based setting. Multiple Y-90 radioembolizations can be safely utilized amongst this population with appropriate dose reductions. Moreover, when compared to historical controls, this small study demonstrated a potential survival benefit. Future large-scale studies will be needed to confirm these findings.

*List of Acronyms*

CI Confidence interval

CRLM Colorectal liver metastasis

CT Computed tomography

ECOG Eastern Cooperative Oncology Group

IQR Interquartile range

LFT Liver function test

MRI Magnetic resonance imaging

OS Overall survival

PFS Progression-free survival

RECIST Response Evaluation Criteria in Solid Tumors

SEER Surveillance, Epidemiology, and End Results

SIRT Selective internal radiation therapy

Tc-99m MAA Technetium-99m macroaggregated albumin

Y-90 Yittrium-90

*Ethical Statement*

This is an IRB approved study (No. 035.HPB.2018.R). Due to the retrospective, minimal-risk nature of the study, the requirement for informed consent was waived by the IRB. All attempts have been made to protect the information and identity of the study subjects.

*Data Availability Statement*

The data that support the findings of this study are available on reasonable request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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*Conflicts of Interest*

Dr. Travis Van Meter is a consultant for SirTex Medical. Dr. D. Rohan Jeyarajah is a consultant for Ethicon Inc., a consultant for Angiodynamics, a consultant for SirTex Medical, and on the Angiodynamics safety monitoring board. Dr. Houssam Osman, Dr. Jessica Heard, and Ms. Sahar Darian have no conflicts of interests or financial ties to disclose.

*Author Contributions*

All authors had full access to the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. *Conceptualization* , T.V., D.R.J, and H.O.; *Methodology* , J.H., S.D., D.R.J., T.V., and H.O.; *Data Collection* , J.H., S.D., and D.R.J., T.V.; *Formal Analysis* , J.H. and R.D.J.; *Resources* , J.H. and S.D.; *Writing - Original Draft* , J.H. and S.D.; *Writing - Review & Editing* , J.H., S.D., T.V. D.R.J., and H.O.; *Visualization* , J.H.; *Supervision* , D.R.J.

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*Tables*

**Table 1.** Baseline Characteristics of the Study Population

Table 1. Baseline Characteristics

**Characteristic**

**Characteristic**

**N (%)**

*Age at the time of Y-90[a] (years)*

*Age at the time of Y-90[a] (years)*

<50

1 (9)

50-64

6 (54.5)

[?]65

4 (36.4)

*Sex*[a]

*Sex*[a]

Male : Female

10:1

*Primary tumor location*[a]

*Primary tumor location*[a]

Rectum

4 (36.4)

Right colon

4 (36.4)

Transverse colon

1 (9.1)

Left colon

2 (18.2)

*Stage at diagnosis*[a]

*Stage at diagnosis*[a]

II

1 (9.1)

III

3 (27.3)

IV

7 (63.6)

*Hepatic metastasis*[a]

*Hepatic metastasis*[a]

Metachronous : synchronous

6 : 5

*Extrahepatic metastasis*[c]

*Extrahepatic metastasis*[c]

Pulmonary only

4 (28.6)

Non-pulmonary

8 (57.1)

*Time to hepatic metastasis from primary diagnosis*[b] (years)

*Time to hepatic metastasis from primary diagnosis*[b] (years)

<1

1 (16.7)

1-2

4 (66.7)

>2

1 (16.7)

*Number of hepatic tumors*[c]

*Number of hepatic tumors*[c]

1

4 (28.6)

2-3

5 (35.7)

4-5

2 (14.3)

[?]6

3 (21.4)

Abbreviations: Y-90, yittrium-90.

[a] Number based on individual patients included in the study (N=11); [b] Among patients with metachronous hepatic metastasis (N=6); [c] Number based on the total therapeutic interventions completed (N=14).

**Table 2.** Therapies Prior to Yttrium-90 Utilization

Table 2. Prior Therapies

**Characteristic**

**Characteristic**

**N (%)**

*Primary colorectal tumor*[a]

*Primary colorectal tumor*[a]

Resected : in situ

8 : 3

*Liver directed therapy*[a]

*Liver directed therapy*[a]

None

6 (54.5)

Ablation

4 (36.4)

Resection

4 (36.4)

*Prior lines of chemotherapy*[b]

*Prior lines of chemotherapy*[b]

1

1 (7.1)

2

5 (35.7)

[?]3

8 (57.1)

*Prior biologic therapy*[b]

*Prior biologic therapy*[b]

0

1 (7.1)

1

9 (64.3)

2

4 (28.6)

Abbreviations: Y-90, yittrium-90.

[a] Number based on individual patients included in the study (N=11); [b] Number based on the total therapeutic interventions completed (N=14).

**Table 3.** Details of Y-90 Radioembolization and Outcomes

| **Detail** | **Detail** | **Value** |
|---|---|---|
| *Median time to initial Y-90 from CRLM (months)*[a] | *Median time to initial Y-90 from CRLM (months)*[a] | 13.6 (14.9) |
| *Median administered activity (mCi)* | *Median administered activity (mCi)* | |
| | Right lobe | 33.08 (13.36) |
| | Left lobe | 15.7 (7.73) |
| | Segment IV | 14.45 (8.20) |
| | Segment II | 10.00 |
| *Median diameter of dominant tumor (cm)* | *Median diameter of dominant tumor (cm)* | |
| | Before Y-90 | 4.0 (5.4) |
| | After Y-90 | 3.7 (6.6) |
| *Median number of hepatic metastatic lesions* | *Median number of hepatic metastatic lesions* | |
| | Before Y-90 | 3 (4) |
| | After Y-90[b] | 2 (4) |
| *Median hepatic progression-free survival (months)* | *Median hepatic progression-free survival (months)* | 5.5 (5.5) |
| *Hepatic progression type*[c] | *Hepatic progression type*[c] | |

| | |
|---|---|
| New lesion(s) | 4 (21.1%) |
| Progression of treated lesion(s) | 5 (35.7%) |
| Combined | 5 (35.7%) |

Abbreviations: CRLM, colorectal liver metastasis; Y-90, Yttrium-90.

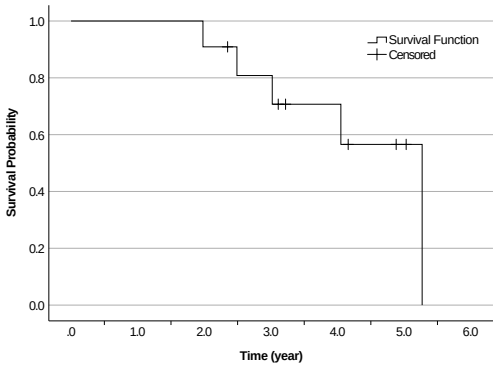
Note: unless otherwise stated, values are the median value with associated interquartile range in parenthesis and N=14.

[a] Number based on individual patients included in the study (N=11); [b] N=8 among the regression group as post-treatment PET-CT did not provide measured size comparison to the pre-treatment MRI; [c] Values represent the number of patients with associated percentage.

*Figure Legends*

**Figure 1.** Kaplan-Meier plot showing an overall survival of 5.3 years from time of primary colorectal cancer diagnosis to death or censor.

**Figure 2.** Kaplan-Meier plot showing a median overall survival of 2.3 years (95% confidence interval 0.3, 4.2) from time of the first yittrium-90 treatment to death or censor.

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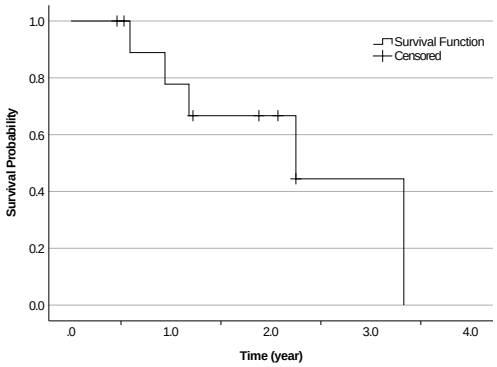


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