Acta Oncologica

ISSN: 0284-186X (Print) 1651-226X (Online) Journal homepage: http://www.tandfonline.com/loi/ionc20

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To cite this article: Sanni Tulokas, Hanna Mäenpää, Erno Peltola, Tero Kivelä, Pia Vihinen, Aku Virta, Siru Mäkelä, Raija Kallio & Micaela Hernberg (2018) Selective internal radiation therapy (SIRT) as treatment for hepatic metastases of uveal melanoma: a Finnish nation-wide retrospective experience, Acta Oncologica, 57:10, 1373-1380, DOI: 10.1080/0284186X.2018.1465587

To link to this article: https://doi.org/10.1080/0284186X.2018.1465587

Published online: 23 Apr 2018.

ACTA ONCOLOGICA
2018, VOL. 57, NO. 10, 1373–1380
https://doi.org/10.1080/0284186X.2018.1465587

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ORIGINAL ARTICLE

Selective internal radiation therapy (SIRT) as treatment for hepatic metastases of uveal melanoma: a Finnish nation-wide retrospective experience

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ABSTRACT

Background: In Finland, selective internal radiation therapy (SIRT) is at present the preferred first-line loco-regional therapy for uveal melanoma patients with hepatic metastases not suitable for surgery. We retrospectively evaluate the outcome and safety of SIRT in this group of patients.

Material and methods: Yttrium-90 microspheres were delivered via the hepatic artery into the circulation of metastases from uveal melanoma in 18 patients with a predicted life expectancy of more than three months in three Finnish tertiary referral centers between November 2010 and December 2015. Progression-free survival (PFS), toxicity and overall survival (OS) were evaluated. Patients with historical uveal melanoma without extrahepatic metastases, who had received systemic chemotherapy as first-line treatment for their hepatic metastases at the Helsinki University Hospital between January 2006 and May 2010, were used as a historical control group.

Results: Partial response and stable disease were observed in three (17%) and eight (44%) patients, respectively; one patient was not evaluable for response. Median PFS after SIRT was 5.6 (range, 1.3–40.8) months. Median OS after SIRT was 13.5 (range, 3.6–44.8) months compared with 10.5 (range, 3.0–16.5; $p = .047$) months for the historical chemotherapy group. Among patients who received SIRT as first-line treatment, the median OS was 18.7 (range, 8.2–44.8) months, significantly longer than that of the chemotherapy group (10.5 months, $p = .017$). There were no treatment-related deaths. Toxicity was mainly WHO grade 1–2 and self-limited.

Conclusion: SIRT is a feasible and safe treatment for liver metastases in patients with uveal melanoma.

ARTICLE HISTORY
Received 31 January 2018
Accepted 8 April 2018

Background

Uveal melanoma is the most common primary intraocular malignancy in adults. The mean age-adjusted incidence is 5.1 per million [1]; but it increases from Southern to Northern latitudes from two to over eight per million [2]. Consequently, Finland is among countries with the highest incidence in the world. Unlike skin melanoma, the age-adjusted incidence of uveal melanoma has remained stable [1,3]. However, because of the aging population structure in Europe, the crude incidence of uveal melanomas is increasing [4]. At the time of diagnosis, the disease is limited to the eye in 98% of the patients even when the intraocular tumor is large [5]. The most common conservative treatment is plaque brachytherapy with ruthenium or iodine isotopes. Enucleation is preferred for patients with large advanced tumors when there is only a minor possibility to save useful vision [6]. Despite successful treatment of the primary tumor, over 50% of the patients develop clinical metastases over the next 30 years [7]. According to the Collaborative Ocular Melanoma Study (COMS), 25% of the patients with medium size to large choroidal melanoma had developed metastases at five years, and 34% of the patients had metastatic disease at 10 years [8].

Uveal melanoma spreads hematogenously. The most common site for metastases is the liver (>90%) followed by the lungs [8,9]. Clinical risk factors for metastatic disease are large tumor size, ciliary body extension and extraocular growth of the primary tumor [10]. Chromosomal abnormalities such as monosomy 3 and amplification of 8q chromosome, mutation in *BAP1* and gene expression profile class 2 identify those at highest risk of metastasis [11], especially when combined with clinical predictors [12,13].

Prognostic models for risk factors associated with survival have been developed [14,15]. Similarly, staging for patients with newly identified metastases have been proposed and validated [16–18]. These models share performance index, a measure of metastatic extent such as the largest dimension of the largest metastasis, and serum levels of transaminases, lactate dehydrogenase (LDH) and alkaline phosphatase (ALP).

Prognosis in metastatic uveal melanoma is poor. The median overall survival (OS) of 249 patients from seven

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Table 1. Inclusion and exclusion criteria for SIRT.

Inclusion	Exclusion
Metastases limited to liver	Extrahepatic metastases
WHO ≤2	Ascites
If both liver lobes involved, portal vein free from tumor	Previous hepatic radiation
Adequate coagulation parameters	Pregnancy
INR <1.5 or TT >25%, APTT normal, Tromb >100 E9/l), Hcr >30%	
Adequate liver function	–
S-Bil <34 μmol/l, S-Alb >30 g/l, AST <175/225 U/l (female/male), ALT <225 U/l	
Adequate kidney function	–
Adequate bone marrow function	–
B-leuk >2.5, B-neut >1.5, B-tromb >100, Hcr >30%	
Life expectancy >3 months	–

WHO: performance status; INR: international normalized ratio (reference value: 0.7–1.2); TT: thrombin time (70–130%); APTT: activated partial thromboplastin time (28–37 s); Tromb: thrombocytes (150–360 E9/l); Hcr: hematocrit (female/male 35–46/39–50%); S-Bil: serum bilirubin (<20 μmol/l); S-Alb: serum albumin (36–45 g/l); AST: aspartate aminotransferase (female/male 15–35/15–45 U/l); ALT: alanine aminotransferase (female/male <35/50 U/l); B-leuk: leucocytes (3.4–8.2 E9/l); B-neut: neutrophils (1.5–6.7 E9/l).

European ocular oncology centers was 13.5 months, and 53% of the patients survived >1 year, 22% survived >2 years and 10% survived >3 years [17]. In this multicenter study, the patient population was heterogenous and were treated with a wide spectrum of different treatment modalities beginning from best supportive care to liver resection.

So far none of the new, effective systemic treatments for cutaneous melanoma has shown substantial efficacy as a treatment for metastatic uveal melanoma. Therefore, several locoregional treatments are in use for metastatic uveal melanoma limited to the liver, such as liver resection, transarterial chemoembolization (TACE), hepatic intra-arterial chemotherapy (HIA), percutaneous hepatic perfusion using melphalan, isolated hepatic perfusion (IHP), immunoembolization, drug-eluting beads and, more recently, selective internal radiation therapy (SIRT) also known as radioembolization [19,20].

Liver metastases receive approximately 80–100% of the blood flow from the hepatic artery, whereas normal liver parenchyma is supplied by the portal vein. The basis of SIRT is to implant into the hepatic arterial circulation microspheres composed of resin or glass particles bound to yttrium-90, a high-energy beta-emitting isotope with a half-life of 64.2 h and an average tissue penetration of 2.5 mm. The resin bead microspheres have a median diameter of 35 μm, which makes them small enough to penetrate into the tumor circulation but too large to enter capillaries and to spread to the lungs [21,22].

Before SIRT became available for liver resection, and to a much lesser extent TACE, were the only locoregional treatments available in Finland. If patients were not suitable for resection or TACE, chemotherapy was the remaining treatment option for these patients. The introduction of SIRT was therefore a welcomed new treatment modality for this group of patients with limited treatment options. In this retrospective study, we reviewed consecutive patients with hepatic metastases from uveal melanoma treated with SIRT in Finland between 2010, when this treatment was introduced in Finland, and 2015. We compared the outcome with a historic cohort of patients fulfilling the inclusion criteria we used for SIRT, treated with systemic chemotherapy for metastatic uveal melanoma between 2006 and 2010 at the Helsinki University Hospital.

Material and methods

Patients

Patients who had undergone SIRT treatment for metastatic uveal melanoma and who had a predicted life expectancy of more than three months were eligible to this study. Life expectancy was clinically estimated based on the performance status, organ functions, progression rate based on consecutive radiological imaging and tumor burden. Inclusion and exclusion criteria for SIRT treatment are listed in Table 1.

In Finland, the diagnosis and treatment of primary uveal melanoma is centralised to the Department of Ophthalmology at the Helsinki University Hospital. Treatment of metastatic uveal melanoma is carried out in regional oncology units. SIRT is available in the Helsinki, Turku and Oulu University Hospitals. Data were collected from these three institutions. Approval from the independent Institutional Review Board for data collection was applied separately from each university hospital.

A total of 19 uveal melanoma patients with liver metastases were treated with SIRT between November 2010 and December 2015. One patient was excluded because of a predicted life expectancy less than three months. Eleven of the remaining 18 patients were treated in Helsinki, 4 in Turku, and 3 in Oulu. Characteristics of patients receiving SIRT are listed in Table 2.

In order to compare outcome of treatment modalities, data were collected from consecutive patients with metastatic uveal melanoma limited to the liver receiving chemotherapy at Helsinki University Hospital between January 2006 and May 2010. A total of 14 patients with metastatic uveal melanoma were identified during this time. The remaining eight patients fulfilled the SIRT inclusion criteria and were thus eligible as controls.

Methods

Extrahepatic metastases were excluded using positron-emission tomography/computed tomography (PET/CT), contrast-enhanced computed tomography (CT) or magnetic resonance imaging (MRI).

Liver angiography was performed approximately two weeks before the treatment to analyse individual vascular structures.

Table 2. Patient characteristics, response and survival of SIRT group.

Patient	Age	DMFS (months)	WHO before SIRT	Hepatic tumor load (%)[a]	Response	PFS (months)	Extrahepatic metastasis after SIRT	Liver progression after SIRT	OS (months)	Elevated LDH
1	64	52	2	27	NE	3.5	–	NE	3.6[b]	Yes
2	68	77	0	16	PD	3.7	–	Yes	5.4[b]	Yes
3	76	120	1	11	PD	4.1	–	Yes	6.7	No
4	70	25	1	24	SD	5.8	LN, lung	Yes	8.2	No
5	55	8	0	20	PD	1.5	Bone	Yes	8.9	Yes
6	68	72	0	NA	PD	1.3	–	Yes	9	No
7	60	25	1	28	PD	5.9	Bone, spleen	Yes	9.9	No
8	55	30	0	3	SD	4.4	Brain	Yes	10.3[b]	No
9	57	15	1	5	SD	3.6	Lung	Yes	12.7	No
10	68	97	0	27	PR	12		Yes	14.3	No
11	63	38	0	0.54	SD	5.6	Lung	Yes	20.7[b]	No
12	59	30	0	0.03	NED	–	–	No	+23	No
13	59	16	0	0.66	SD	9	LN, bone, lung, soft tissue	Yes	23.7	No
14	72	113	0	29	PR	4.3	Lung, bone, soft tissue	Yes	24.8	Yes
15	50	0	0	6	SD	24.9	Bone	Yes	25.2	No
16	65	99	0	10	SD	17.4	Bone	Yes	30	No
17	69	49	0	21	PR	18.2	Lung	Yes	+40.6	No
18	32	68	0	24	SD	40.8	–	Yes	+44.7	No

Age: age at diagnosis of metastatic disease; DMFS: distant metastasis-free survival; WHO: performance status; OS: overall survival; LN: lymph node; NE: not evaluable; NED: no evidence of disease; PD: progressive disease; PFS: progression-free survival; PR: partial response; SD: stable disease; +: patient alive.
[a]Tumor load cm^3/liver volume cm^3; [b]SIRT 2nd/salvage.

At the same time, non-target extrahepatic vessels were embolised. Technetium (^{99m}Tc)-macroaggregated albumin was injected into the hepatic arteries, followed by whole body scanning and single-photon emission computed tomography (SPECT) to detect unintentional delivery of the microspheres into extrahepatic organs and to estimate the degree of shunting to the lungs.

To calculate the activity delivered to each liver lobe, three-phase liver CT was used to measure the volumes of the tumors in relationship to that of the liver. In order to proceed to SIRT, less than 50% of the liver was allowed to be infiltrated by metastases. The activity of yttrium-90 in the microspheres was calculated by using the body surface area (BSA) method, which assumes that BSA is correlated with the size of the liver [21]. The right and the left lobe were treated in one or two sessions at 2–4 weeks intervals. The median total dose administered was 1.9 GBq per patient (range, 0.7–2.54).

Bremsstrahlung scanning was done the day after the treatment to evaluate the distribution of microspheres. After treatment, the patients were clinically assessed and laboratory tests were taken every two weeks for two months, to monitor acute toxicity. Dexamethasone (4.5 mg b.i.d.) combined with a proton-pump inhibitor was offered for three to four weeks after SIRT to alleviate possible side effects of radiation.

Data of side effects were collected retrospectively from the patient charts. Hepatic toxicity was evaluated by using the Common Terminology Criteria for Adverse Events (CTCAE) version 4.0.

Response was evaluated according to the Response Evaluation Criteria in Solid Tumours (RECIST) version 1.1 [23]. The first CT scan to evaluate response after the treatment were made in Oulu at six weeks, in Helsinki at two months, and in Turku at three months after SIRT, and thereafter at three-month intervals until progression. The same radiological examinations used at baseline were also used for monitoring response. In Helsinki, CT was used, in Oulu MRI, and in Turku PET-CT or MRI. CT scans were performed for 12 patients, MRI for 3, MRI + CT for 2 and PET-CT for 1 patient. The response evaluation was performed by the interventional radiologist for all patients but due to the retrospective nature of this study six patients did not have a response evaluation CT scan available after the baseline imaging.

Statistical methods

Distant metastasis-free survival (DMFS) was measured from the day of diagnosis of primary uveal melanoma to radiological confirmation of liver metastases. Progression-free survival (PFS) was measured from the day of SIRT to radiological confirmation of progression. OS was calculated from the day of SIRT or the first day of chemotherapy to death or last follow-up of the patient. The last follow-up date was 28 December 2017. OS for both groups was estimated by using the Kaplan–Meier analysis. Survival curves were compared using the log-rank test. A p value $<.05$ was considered significant.

Results

Four of the 18 patients had received systemic chemotherapy prior to SIRT as first-line therapy, and one of these patients had been treated with two lines of chemotherapy before SIRT. The median age at the time of the primary tumor was 58 years (range, 26–68 years). Median age at the diagnosis of metastatic disease was 63 years (range, 32–76 years). Median time to SIRT after verified hepatic metastases was 3.6 months (range, 1.2–10.8 months). Seventeen patients underwent SIRT

Table 3. Patient characteristics, treatment and survival in the chemotherapy group.

Patient	Age	DMFS	Number of treatment lines	OS (months)
1	72	47	1	3.0
2	69	37	1	6.0
3	67	0	2	6.8
4	66	134	3	8.1
5	38	202	1	12.8
6	48	12	2	13.0
7	42	11	3	14.1
8	63	16	2	16.5

Age: age at metastatic disease; DMFS: distant metastasis-free survival; OS: overall survival.

once and one patient four times. Further, patient characteristics are listed in Table 2.

In the chemotherapy group, median age at the diagnosis of primary disease was 55 years (range, 27–72 years). Median age at the diagnosis of metastatic disease was 64 years (range, 38–72years). Single-agent dacarbazine was most commonly used as first-line chemotherapy. More detailed patients' characteristics are presented in Table 3.

Response to SIRT

The best radiologic response was partial response (PR) for three patients (17%), eight patients (44%) had stable disease (SD) and five (28%) had progressive disease (PD). One patient (6%) was not evaluable for response because the hepatic metastases could not be reliably measured on CT or MRI. Prior to the treatment, the metastatic lesions had been found by laparoscopy. One patient (6%) died before diagnostic response examination.

Survival

The median follow-up time was 13.5 months (range, 3.6–40.8 months). The median PFS was 5.6 months (range, 1.3–40.8 months). One patient has no evidence of hepatic progression or extrahepatic metastases. Two other surviving patients progressed, and one of them also developed extrahepatic metastases.

The median OS after verification of hepatic metastases was 19.6 months (range, 8.8–48 months) for the SIRT group and 15.5 months for the chemotherapy group (range, 5.9–19months).

Fifteen patients died during follow-up, including four patients who received SIRT as second-line salvage therapy after chemotherapy. Eleven patients (61%) developed extrahepatic metastases after SIRT, including pulmonary, subcutaneous, bone, lymph node, spleen and cerebral metastases (Table 2). Sixteen patients (89%) showed progression of hepatic metastases and 14 of them received chemotherapy, surgical treatment, immunological treatment, radiation therapy or a combination of these treatments after progression. The median OS was 13.5 months (range, 3.6–44.7 months) from the day of SIRT to death.

In the control group one patient received a combination of docetaxel and cisplatin, and the remaining seven patients received dacarbazine as the first-line treatment. Five of the eight patients received second-line treatment after PD. One of these five patients received TACE and the remaining four received chemotherapy as the second-line treatment. Two of the patients received third-line treatment after progression. Median OS was 10.5 months (range, 3–16.5 months).

The difference in median OS between the 14 patients who received SIRT as the first-line treatment (18.7 months; range, 6.7–44.7) and chemotherapy (10.5 months; range, 3–16.5) was statistically significant ($p = .017$) (Figure 1). The median OS (13.5 months; range, 3.6–44.7) of the whole SIRT group ($n = 18$) was also statistically significant compared with the chemotherapy group OS ($p = .047$).

The median OS among the four patients who received SIRT as salvage therapy was significantly lower than that of those who were treated first-line (7.8 vs. 18.7 months; $p = .045$) (Figure 2).

To evaluate possible selection bias regarding centers, we compared the outcome between the two treatment groups treated in Helsinki University Hospital. Median OS for the 11 SIRT-treated patients was 20.7 months (range, 8.2–44.7 months) compared to 10.5 months for the chemotherapy group (range, 3–16.5 months; $p = .01$).

Prognostic factors known to influence OS were analyzed by comparing pretreatment values of serum LDH. Four patients had elevated LDH. Median OS for patients with elevated LDH ($n = 4$) prior to SIRT appeared to be lower than it was for patients with normal LDH levels (7.2 vs. 17.5 months; $p = .066$). Elevated ALP ($n = 4$) had no statistically significant influence to OS ($p = .83$).

We also tested variables suggested to be prognostic factors for survival in previous studies: gender, hepatic tumor load, age (younger than vs. older than 60 years) and DMFS (more vs. less than 24 months). These factors were not statistically significant in our small series.

Toxicity

No SIRT-related deaths were observed. One procedure-related complication occurred during preparatory arteriography when a hepatic artery was dissected. SIRT was postponed and successfully performed four months later.

Eleven patients developed grade 1–2 increase of transaminases. One patient had grade 3 and one had grade 4 elevation of transaminases. Other mild, self-limited toxicity (grade 1–2) was reported for 15 patients, including nausea, abdominal discomfort/pain, tiredness and subfebrility. One patient was hospitalized due to fever (38.7˚C, grade 1) in relation to liver toxicity; this patient had received DTIC chemotherapy five months before SIRT.

The chemotherapy group had more pronounced treatment-related side effects such as nausea, infections, declining performance status, liver and hematological toxicity.

Discussion

In this nationwide study, we analyzed the outcome of 18 consecutive patients with metastatic uveal melanoma

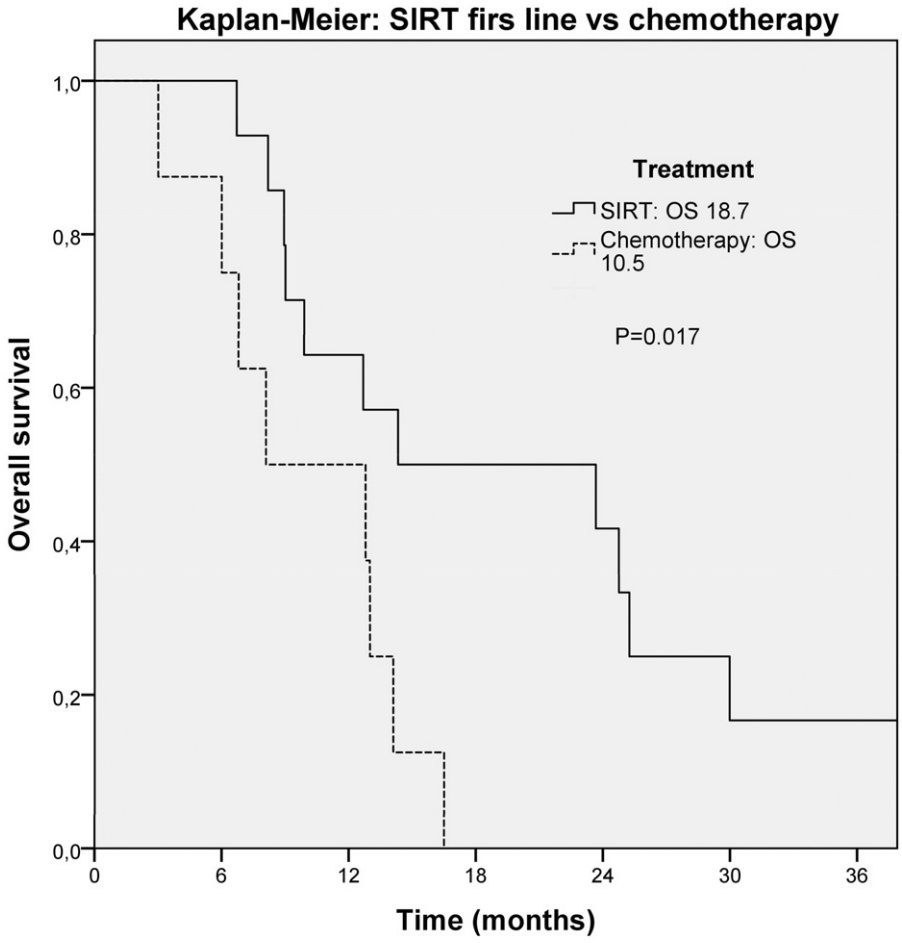

Figure 1. Overall survival for patients treated with SIRT in first line ($n = 14$) versus chemotherapy ($n = 8$; $p = .017$).

without extrahepatic metastases ineligible for surgery receiving SIRT as first-line or salvage therapy. The patients had better outcome if they received SIRT as a first-line therapy instead of chemotherapy. As other locoregional treatment modalities are only rarely used for treating hepatic metastases of uveal melanoma in Finland, we have limited the discussion to compare results between studies where SIRT has been used as treatment for hepatic metastases of uveal melanoma.

Metastatic uveal melanoma is a rare malignancy. To our best knowledge, no prospective studies analyzing the efficacy of SIRT have been reported so far. Only a few retrospective studies are available with a limited number of patients for comparison. Differences in the patient characteristics in these studies complicate a direct comparison. The retrospective nature of the present study naturally sets limitations when interpreting results and comparison between the two treatment modalities should be interpreted with caution. Treatment-related toxicity was observed in both cohorts. In total, SIRT seemed to be better tolerated than chemotherapy. Toxicity related to SIRT was mainly self-limited, whereas chemotherapy was related to more long-lasting side effects. These findings seem to be in line with what has been reported elsewhere [24–27].

Our study included 14 patients who received SIRT as the first-line therapy. The median OS among these patients was significantly longer compared with the historical control group treated with the first-line chemotherapy ($p = .017$). The median OS of 18.7 months is also the best outcome reported for patients treated with SIRT in first line. Apparently, only three earlier studies have reported results on SIRT as first-line treatment. In the largest of these studies comprising 71 patients (including 13 patients treated with SIRT in first line) the median OS was 12.3 months for all patients and the median OS was not reached in the first-line group (Table 4) [28].

Various chemotherapeutic and immunomodulatory agents and combinations have been investigated showing poor outcome with median OS from 6 to 14 months [29]. Over 20 years, TACE has been used for the treatment of hepatic metastases and several chemotherapeutic agents have been tested [19]. In a review by Agarwala et al. [29], median OS ranged from 5.0 to 8.9 months for patients receiving TACE for hepatic metastases from either uveal or cutaneous melanoma. More promising survival rates were reported in a retrospective analysis of 141 patients, where TACE in combination with CPT-11 charged microbeads ($n = 58$) was compared with historical treatments ($n = 83$) (median OS, 16.5 vs. 12.2 months) [30].

Predictive factors for hepatic PFS and OS for 71 patients were analyzed in the largest reported study so far. In the univariate analysis, female gender, pretreatment metabolic tumor volume and total glycolic uptake on PET-CT correlated with hepatic PFS and OS [28]. In another study with 32

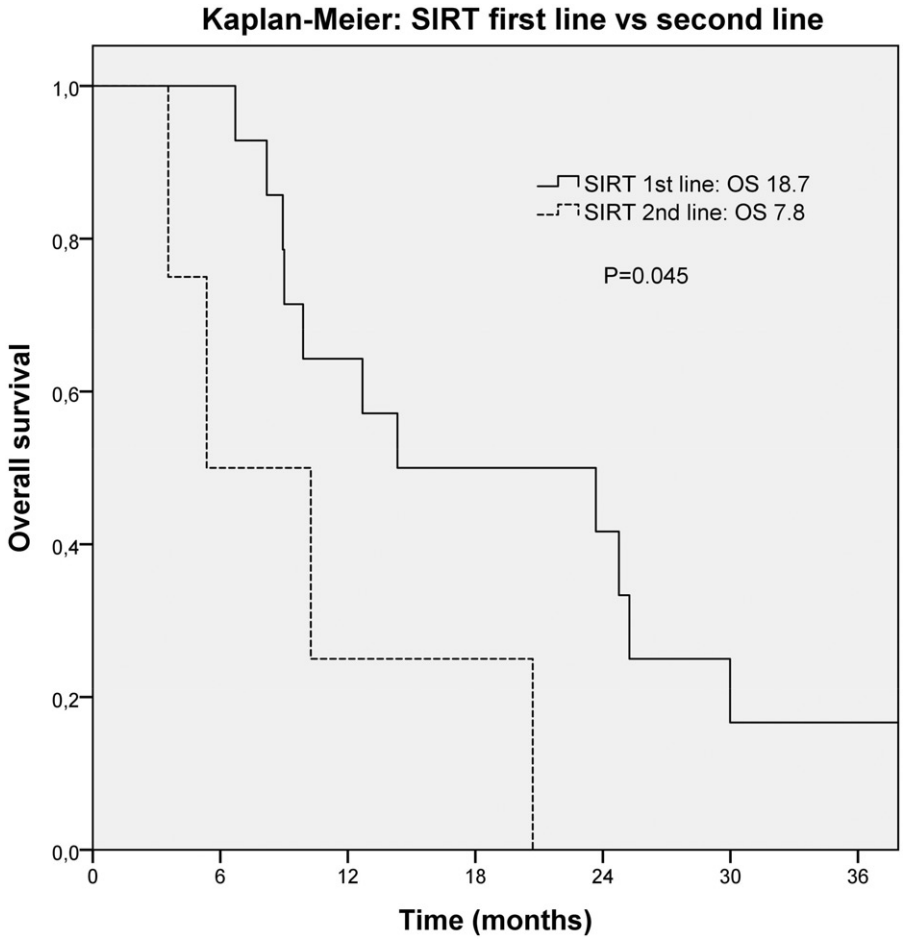

Figure 2. Overall survival for patients treated with SIRT in first line ($n = 14$) versus SIRT as second-line treatment ($n = 4$; $p = .045$).

Table 4. Published data on SIRT as treatment for metastatic melanoma limited to the liver.

Study	Patients (*n*)	SIRT 1st and 2nd/salvage	Response (RECIST) CR + PR (%)	Response (RECIST) SD (%)	PFS (months)	Median OS (months)
Kennedy [24]	11	At least some 2nd/salvage	77	11	NR	Not reached; 1-year OS 80%
Klingenstein [25]	13	1st: 2 2nd/salvage: 11	62	15	NR	7.0
Gonsalves [26][a]	32	1st: 0 2nd/salvage:	6	56	4.7	10.0
Eldredge-Hindy [28]	71	1st: 13 2nd/salvage: 58	8	52	5.9	1st: not reached 1st: + salvage: 12.3
Schelhorn [27]	8	1st: 0 2nd/salvage: 8	0	50	1.0	3.0
Xing [32]	SIRT: 15	1st: 0 2nd/salvage: 15	–	–	–	10.9
Present study	SIRT: 18 Ctx: 8	1st: 14 2nd/salvage: 4 1st: 8	17	44	5.6	SIRT: 13.5 1st: 18.7 Ctx: 10.5

CR: complete response; Ctx: chemotherapy; OS: overall survival; NR: not reported; PFS: progression-free survival; PR: partial response; SD: stable disease; 1st: first-line treatment; 2nd/salvage: second-line treatment; +: patient alive.
[a]Most patients included also in the study by Eldredge-Hindy [28].

patients treated with SIRT as the second-line therapy, the effect of tumor burden on treatment outcome was evaluated. Patients with a pretreatment tumor burden of <25% of the total liver volume had significantly longer PFS than patients with burden >25% (6.4 vs. 3.0 months) [26]. In our study, the median liver involvement was only 16% (range, 0.03–29) and only four patients had a tumor burden >25%, which is low compared with other studies [26,27]. The smaller tumor volume could be one explanation why the outcome of our patients was slightly better compared to that of patients in other studies. Similar to skin melanoma, larger tumor volume also correlates with elevated LDH level, which seems to be related to shorter OS as compared to patients with normal LDH levels [31]. In our series, only 22% of the patients had elevated LDH, which supports this observation.

The reported efficacy of SIRT as the second-line treatment is somewhat more modest (Table 4). The risk of extrahepatic metastases increases with progression of disease, and prior

chemotherapy may expose patients to increased liver toxicity favoring a strategy to use SIRT as early as possible. In our study, only four patients received SIRT as the second-line treatment after chemotherapy. The median OS of these patients was only 7.8 months. Others have reported similar or even more modest efficacy for SIRT as a salvage therapy. The number of patients reported to have received salvage treatment are small, and the patient populations are heterogenous. There may also be a selection bias, as these patients have maintained a good performance status, may have a smaller tumor burden and less aggressive progression of disease.

In Finland, SIRT is at present the preferred first-line locoregional therapy for patients not suitable for surgery, and chemotherapy is now rarely used as a first-line treatment for this group of patients. Our present results seem to support this approach.

Based on the previously reported studies [24–26,28,32] as well as the results of our study, one can conclude that SIRT is generally well tolerated and more effective as the first-line treatment for metastatic uveal melanoma limited to the liver. Based on the results from this study and another study, it seems that patients with moderate tumor burden may benefit more from SIRT [26]. The small number of patients limits the analysis of prognostic factors in our and most of the other studies [24,25,27,32].

Response evaluation after SIRT is challenging due to changes in the liver caused by the SIRT treatment itself. Thus, this also influences reliability of evaluating PFS. As long as there is no efficient systemic therapy for these patients, median OS is the most reliable factor to evaluate treatment efficacy.

In the future, it may be interesting to consider systemic therapy, i.e., immunotherapy, after SIRT because radiation therapy is known to increase the expression of antigens as targets for the activated immune system [33,34]. Ongoing randomized trials may refine the role of SIRT in the near future as treatment for uveal melanoma without extrahepatic metastases.

Conclusion

In our small retrospective study, SIRT was well tolerated and some treatment benefit was proven. Together with earlier retrospective studies, our results support that SIRT is safe and may be given as the first-line therapy to patients with metastatic uveal melanoma with metastases confined to the liver not eligible for surgery.

Disclosure statement

No potential conflict of interest was reported by the authors.

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