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Efficacy of Transarterial ^{Y90} Radioembolization in Management for Unresectable-Intermediate and Locally Advanced-HCC

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Abstract

Background: Egypt has the highest prevalence of HCV worldwide and has rising rates of hepatocellular carcinoma (HCC). Many have adopted the Barcelona Clinic Liver Cancer (BCLC) staging classification, which links the stage of the disease to a specific treatment strategy. More controversial than the prognostic scoring system is the treatment algorithm that is a part of the BCLC. TACE is usually recommended as the standard treatment of BCLC-B patients, yet it is a relatively contraindicated in BCLC-C1 patients. Radioembolization with yttrium-90 (Y^{90}) is a recently introduced liver-directed therapy, it is a is a sort of internal brachytherapy by arterially injected yttrium-90 (Y^{90}) microspheres for the treatment of HCC. Growing data suggest that (Y^{90}) radioembolization has a potent anticancer effect with negligible adverse events if appropriate pretreatment evaluations. It can be used in BCLC-B and BCLC-C1 in an unselective manner. In contrast to TACE, the rate of adverse effects after such "unselective" application, as performed over a lobar branch of the hepatic artery, is not significantly increased as compared to segmental or even subsegmental microsphere application, although the tumor response rate may vary.

Aim of Study: This study aims to present and discuss the efficacy and clinical outcome of Y^{90} radioembolization using Y^{90} microsphere for management of patients with intermediate and locally advanced (BCLC-B and BCLC-C1) Hepato-Cellular Carcinoma (HCC).

Patients and Methods: This is a prospective study carried out between June 2014 and May 2016 for patients with hepatocellular carcinoma and liver restricted disease. All patients underwent treatment by Y^{90} microsphere radioembolization (SIR-Tex). A total number of 20 patients with intermediate and locally hepatocellular carcinoma and liver restricted disease, not eligible for curative treatment.

Results: Assessment was done according to RECIST and mRECIST guidelines. We found good therapeutic response in patients treated with Y^{90} radioembolization. The complete response, partial response, stable disease and disease progression rates for the study sample after 3 months using the conventional RECIST criteria was 0%, 55%, 30% and 10%, while after 6 months it became 0, 50%, 20% and 25% respectively.

Conclusion: Y^{90} microspheres radioembolization for patients with intermediate and advanced HCC is an effective treatment which can be utilized even in patients with compromised liver function.

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Introduction

HEPATOCELLULAR carcinoma (HCC), a primary malignant tumor of the liver, is the sixth most common cancer worldwide and the third most common cause of cancer-related death [1]. Transplantation and resection and in certain cases by radiofrequency ablation remain the only potentially curative options [2]. However, most patients present with either unresectable (intermediate or advanced) tumors, cirrhosis, or both, eliminating these surgical treatment choices [3].

Although there is no universally accepted HCC staging system, many have adopted the Barcelona Clinic Liver Cancer (BCLC) staging classification, which links the stage of the disease to a specific treatment strategy [1]. BCLC takes into account size and extent of the primary tumor, liver function and physiological factors and incorporates the Okuda stage and Child-Pugh score. There is a corresponding treatment schedule for each stage ranging from curative therapies such as resection or transplant for early stage patients to best supportive care for end-stage patients [4]. Yet, it lacks discrimination within the intermediate stage (BCLC-B) patients, a large proportion of the HCC population. The burden of liver disease which falls under BCLC stage B can vary greatly, from four small tumors to near complete replacement of the liver by tumor, provided liver function is preserved

and there is no vascular invasion, extrahepatic spread, or compromised performance status, which would upstage to BCLC stage C or D [4].

Current guidelines recommend transarterial chemoembolization (TACE) as the standard treatment of Barcelona-Clinic Liver Cancer (BCLC)-B patients, however, the long-term survival outcomes of patients managed with this technique do not appear fully satisfactory [5]. In addition, HCC has traditionally been regarded as a radioresistant tumor due to the limited ability to deliver lethal doses using external beam techniques [6].

Radioembolization with yttrium-90 microspheres is a recently introduced liver-directed therapy employing a catheter-based approach [5] Radioembolization (RE) is brachytherapy by arterially injected yttrium-90 (Y^{90}) microspheres for the treatment of malignancies [7].

This modality involves the arterial infusion of glass or resin microspheres labeled with a radiotherapeutic agent (Yttrium-90 Y^{90}) which are similarly administered via percutaneously placed catheters positioned in the hepatic arterial system. Radioembolization is a form of brachytherapy that allows for concentrated beta-radiation administration to tumor tissue while minimizing damage to surrounding liver parenchyma [8].

Moreover, in a randomized controlled trial done by LoCM et al., [9] they concluded that in cases where there is an invasion of the portal vein, embolic forms of liver-directed therapy for HCC such as TAE or TACE are relatively contraindicated. This relative contraindication is attributable to the embolic effect of TAE/TACE on the hepatic artery, leaving the portal vein as the sole source of blood supply to the liver. If this supply is compromised, such as in the presence of PVT (malignant or bland) ischemic necrosis becomes a possibility [10]. So, despite the fact that this therapy-Y^{90} Radioembolization-is an embolization procedure, the small sizes of the Y^{90} particles causes an embolization at a microvascular level for permanent vascular blockade.

Growing data suggest that Y^{90} radioembolization has a potent anticancer effect with negligible adverse events if appropriate pretreatment evaluations including dosimetry, calculation of lung shunt fraction and assessment of vascular anatomy are performed. Retrospective and small prospective studies have shown response rates and survival after Y^{90} therapy which are comparable to TACE and sorafenib in the intermediate and advanced stages, respectively [5].

Patients and Methods

Patients:

This is a prospective study carried out in private hospitals between June 2014 and May 2016 for patients with hepatocellular carcinoma and liver restricted disease. All patients underwent treatment by Y^{90} microsphere radioembolization (SIR-Tex).

A total number of 20 patients (18 males and 2 females), with intermediate (BCLC class B) and locally advanced (BCLC class C-1) hepatocellular carcinoma and liver restricted disease, not eligible for curative treatment with Eastern Cooperative Oncology Group (ECOG) performance status 0,1 or 2 and Child-Pugh A to B.

Inclusion criteria:

- Patients with HCC, by typical appearance on imaging and/or cytohistological evaluation (liver biopsy).
- Accurate staging: CT and/or MRI of the liver, CT-scan of the abdomen and thorax.
- Cooperative Oncology Group (ECOG) performance status 0,1 or 2.
- Child-Pugh A to B.
- BCLC class B to C-1.
- Bilirubin level <2.
- Liver restricted disease.

Exclusion criteria:

- Unmanageable intolerance to the contrast medium.
- Pregnancy or breast feeding.
- Child-Pugh score >B.
- Bilirubin >2mg/dl.
- Other contraindications to hepatic embolization procedures (e.g coagulopathy).

Intervention:

The procedure was carried out over two separate sessions; a work-up session and a treatment session.

A- *Preparation Angiogram:* Once a patient has been selected as a candidate for Y^{90} radioembolization, an initial angiographic evaluation is performed. This is done primarily to document the visceral anatomy, identify anatomic variants, and isolate the hepatic circulation by occluding extrahepatic vessels. This is very important; because it determines the overall safety of the treatment.

The technique includes standard visceral angiography using a hooked catheter such as a Cobra-

2 or a Simmons 1 or 2. First, an aortic angiogram is performed, seconed step is the superior mesenteric arteriogram, to assess for the presence of accessory or replaced hepatic arteries arising from the superior mesenteric artery (SMA). Next, the celiac trunk is selectively catheterized to evaluate the hepatic arterial supply. Subsequent to celiac injection, it is imperative that selective right and left hepatic angiography with power injection angiography be performed.

Other arteries should be catheterized include, Proper hepatic angiogram, right hepatic angiogram, left hepatic angiogram, gastroduodenal artery and phrenic arteries. This detailed visceral angiogram allows for the identification of variant mesenteric anatomy, and the extrahepatic vessels, as the radioactive microspheres, administered into the hepatic artery, should be prevented from ending up in extrahepatic organs. Accordingly, prophylactic embolization (using coils) of extrahepatic vessels such as the gastroduodenal, right gastric, or falciform artery maybe performed. Once the anatomy has been established, selective arteriography is performed in the expected location of the Y^{90} radioembolization treatment. Microcatheters should be used (Renegade Hi-flow [Boston Scientific, Natick, MA], Progreat [Terumo, Somerset, NJ], or 2.3-French Prowler Plus [Cordis, Miami, FL]).

B- Injection of (^{99m}Tc-MAA): Once a catheter has been placed into the appropriate location, 150 MBq Technetium-99 labeled macro aggregated albumin (^{99m}Tc-MAA) was injected. It is recommended that 99mTc-MAA injection be performed once all vessels of concern have been embolized. 99mTc-MAA is used as a surrogate in order to predict the distribution pattern of Y^{90}-microspheres. The distribution of ^{99m}Tc-MAA will be visualized by whole body planar imaging. Accordingly, lung shunt fraction can be calculated and deposition of ^{99m}Tc-MAA in the abdominal organs, such as the stomach, duodenum and pancreas, can indicate patent extrahepatic vessels distal to the injection site. In case a lung dose exceeding 30 Gy (610 MBq) is predicted, an activity reduction was prescribed.

The ^{99m}Tc-MAA scan can also demonstrate the presence of any GI flow. The shunting evaluation allows the physician to plan for radioembolization therapy and minimize any uncertainty in microspheres distribution at the time of treatment.

C- Y^{90} microsphere injection: Finally, the last step of Y^{90} microspheres injection should take place within two weeks of the 1^{st} seesion. The hepatic artery will be catheterized and the Y^{90} microspheres will be administered from the exact same microcatheter position as where the ^{99m}Tc-MAA was administered.

Post-procedure care All patients underwent Y^{90} radioembolization were hospitalized overnight for observation and administration of medications as needed. All patients were monitored for mild side effects and symptoms including pain requiring oral analgesics, fever, vomiting or nausea and for severe symptoms including pain requiring parenteral analgesics or hemorrhage.

Imaging analysis: Quantifying Size Reduction and Necrosis.

Tumor response by cross-sectional imaging either by CT and/or MRI was evaluated on all surviving patients 1 and 3 months after treatment and approximately every 3 months thereafter, and was categorized according to Response Evaluation Criteria in Solid Tumors (RECIST) and the modified RECIST criteria. Responding disease are seen in patient had complete response (CR) or partial response (PR) while patients had either stable disease (SD) or progressive disease (PD) considered non responding disease.

Results

Twenty patients with Hepato-Cellular Carcinoma underwent Y^{90} radioembolization were included in this study and were retrospectively evaluated.

Baseline tumor imaging characteristic:

The imaging characteristics of the tumors are summarized in Table (1), where the tumor involvement was stratified as less than or more than 25% of the liver size, presence or absence of portal vein tumoral thrombus, lobar distribution of the lesions, BCLC stage and presence or absence of extrahepatic disease.

Tumor response:

Assessment was done according to RECIST and mRECIST guidelines.

As shown in Figs. (1,2), the complete response, partial response, stable disease and disease progression rates for the study sample after 3 months using the conventional RECIST criteria was 0%, 55%, 30% and 10%, while after 6 months it became 0, 50%, 20% and 25% respectively.

When applying the mRECIST criteria, these figures changed to 10%, 55%, 20% and 10% after 3 months and 10%, 50%, 15% and 20% respectively.

Statistical analysis:

Results were expressed as mean ± SD, median and range, or frequencies (number of cases) and percentages when appropriate or number (%).

Comparison between categorical data was performed using Chi square test. Statistical analysis was performed with the aid of the SPSS computer program (version 19 windows).

The data were considered significant if p-value was ≤0.05 and highly significant if p-value was <0.01.

Table (1): Baseline tumor imaging characteristics.

	Parameter	Number	Frequency
Tumor involvement of the liver	≤25%	8	40%
	>25%	12	60%
Portal Vein Thrombosis	Thrombosis	11	55%
		4 Right PV, 4 Left PV, 3 Main PV	
	Patent	9	45%
Lobar Distribution	Right Lobe	16	80%
	Left Lobe	4	20%
Tumor Focality	Single	15	75%
	Multicentric	5	25%
BCLC stage	Stage B	9	45%
	Stage C1	11	55%
Extrahepatic disease	Present	2	10%
	Absent	18	80%

Table (2): 6 months tumor response in relation to the pts demographics.

	Age	Bil.	Alb	Dose	Lesion Size
Complete:					
Mean	58.50	0.800	3.850	1.950	17.600%
N	2	2	2	2	2
Std. Deviation	2.121	0.1414	0.4950	0.0707	24.6073%
Minimum	57	0.7	3.5	1.9	0.2%
Maximum	60	0.9	4.2	2.0	35.0%
Median	58.50	0.800	3.850	1.950	17.600%
Dead:					
Mean	59.00	0.900	4.000	2.000	40.000%
N	1	1	1	1	1
Std. Deviation	.	.	.	.	.
Minimum	59	0.9	4.0	2.0	40.0%
Maximum	59	0.9	4.0	2.0	40.0%
Median	59.00	0.900	4.000	2.000	40.000%
Partial:					
Mean	61.10	1.070	3.580	1.900	30.000%
N	10	10	10	10	10
Std. Deviation	6.082	0.2163	0.6303	0.2108	8.4984%
Minimum	48	0.8	2.6	1.6	15.0%
Maximum	68	1.4	4.5	2.2	45.0%
Median	63.50	1.000	3.700	1.900	30.000%
Progression:					
Mean	57.50	1.075	3.850	2.025	31.250%
N	4	4	4	4	4
Std. Deviation	4.123	0.2500	0.5916	0.3096	4.7871%
Minimum	52	0.8	3.0	1.6	25.0%
Maximum	62	1.4	4.3	2.3	35.0%
Median	58.00	1.050	4.050	2.100	32.500%
Stable:					
Mean	61.67	1.000	3.500	1.667	25.000%
N	3	3	3	3	3
Std. Deviation	5.033	0.2000	0.8660	0.0577	5.0000%
Minimum	57	0.8	3.0	1.6	20.0%
Maximum	67	1.2	4.5	1.7	30.0%
Median	61.00	1.000	3.000	1.700	25.000%
Total:					
Mean	60.10	1.025	3.670	1.900	28.760%
N	20	20	20	20	20
Std. Deviation	5.077	0.2124	0.6001	0.2224	9.8202%
Minimum	48	0.7	2.6	1.6	0.2%
Maximum	68	1.4	4.5	2.3	45.0%
Median	60.50	1.000	3.850	1.900	30.000%

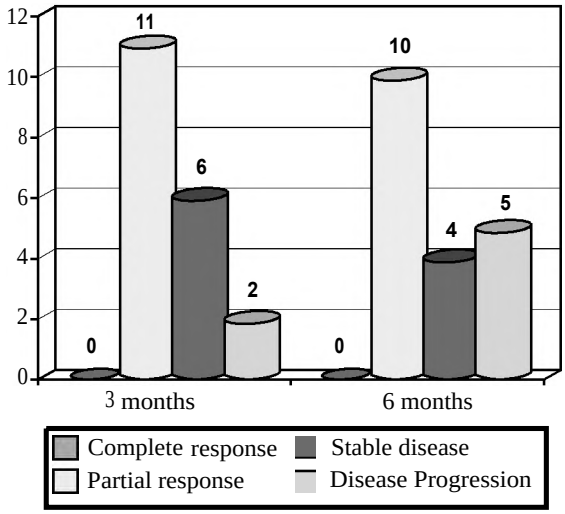

Fig. (1): Tumor response according to RECIST criteria.

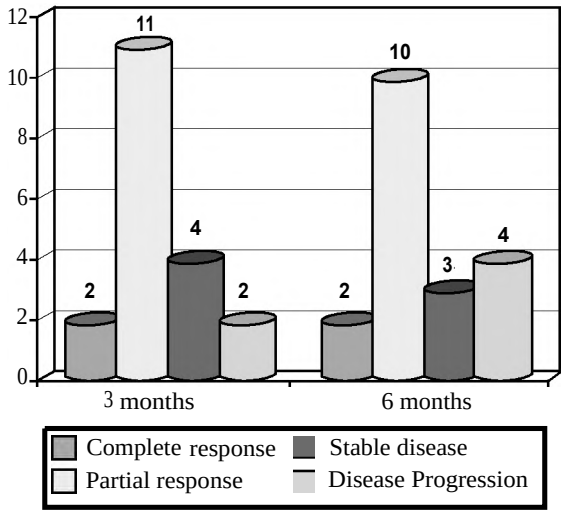

Fig. (2): Tumor response according to mRECIST criteria.

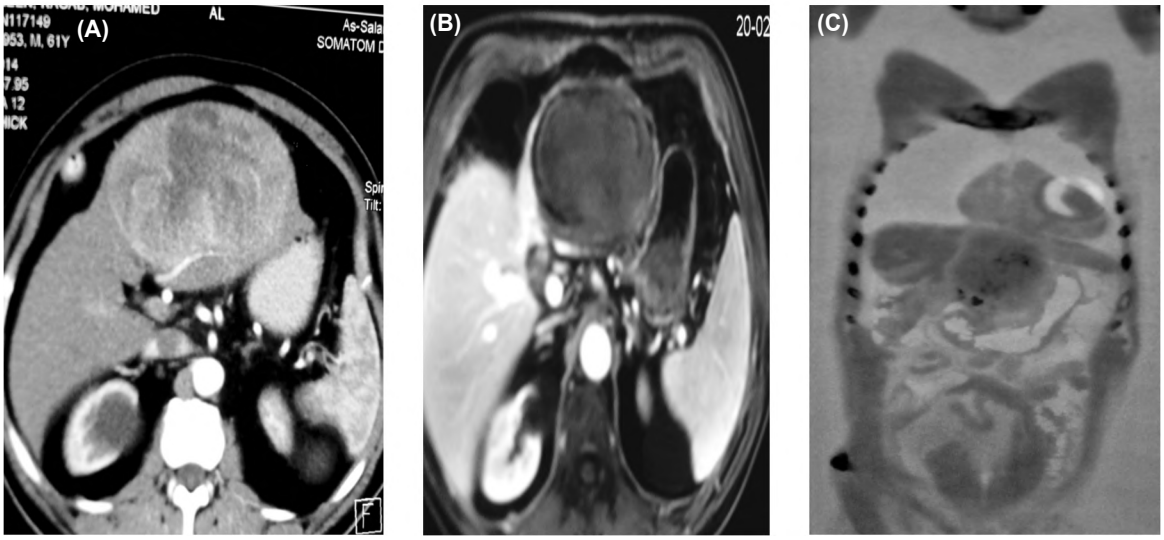

Fig. (3): (A): CT scan showing large left hepatic lobe hypervascular lesion with contour bulge and central breakdown. (B): MRI scan 3 months post $^{Y-90}$ radioemboliztion showing no evidence of pathological tumoral enhancement. (C): Coronal PET/CT scan 6month post $^{Y-90}$ radioemboliztion decrease in the tumor size with no evidence of tumoral activity.

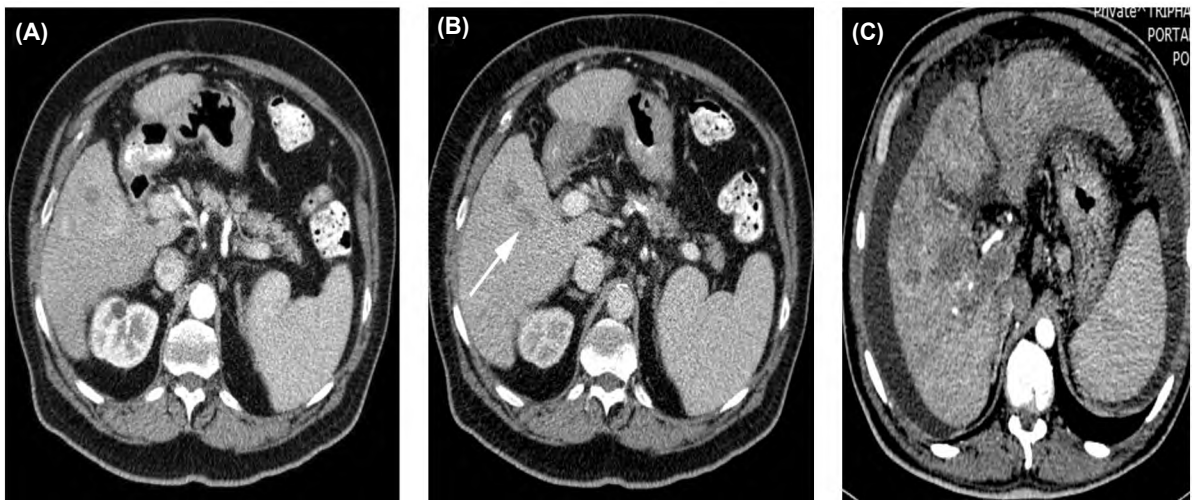

Fig. (4): (A,B): Axial CT images showing multiple enhancing focal lesions involving the right lobe of the liver, and showing element of contrast washout (arrow (C): Axial CT scan 6month post ^{90}Y radioemboliztion showing tumor progression with portal vein invasion as well as newly developed perihepatic ascites.

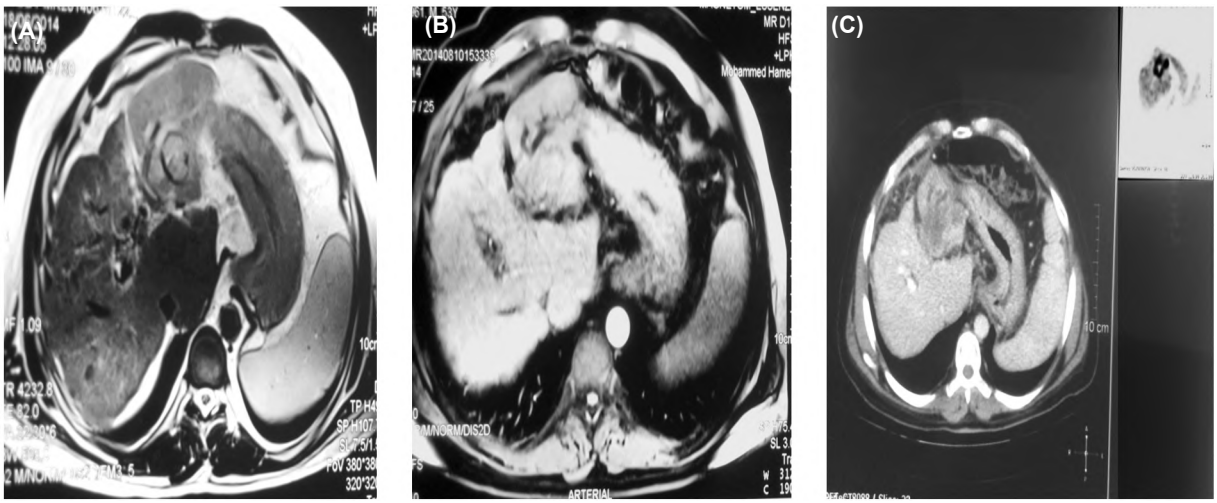

Fig. (5): (A): MRI scan showing left lobe lesion with segmental left portal vein thrombosis and cholestasis. (B): MRI scan 3 months post ^{Y90} radioemboliztion showing stable lesion size yet with differential tumoral enhancement. (C): PET/CT scan 6 month post ^{Y90} radioemboliztion showing partial response, with tumor size reduction and residual peripheral activity.

Discussion

Hepatocellular carcinoma (HCC), a primary malignant tumor of the liver, is the sixth most common cancer worldwide and the third most common cause of cancer-related death **[1]**.

Transplantation and resection and in certain cases radiofrequency ablation remain the only potentially curative options **[2]**.

In addition, local-regional treatments play a key role in the management of hepatocellular carcinoma (HCC) **[11]**.

However, and despite the widespread implementation of surveillance programs, more than half of the patients with HCC are diagnosed late, when curative treatments cannot be applied.

According to the BCLC staging system and recommended treatment strategy, patients with early stage HCC can benefit from curative therapies, including surgical resection, liver transplantation and percutaneous ablation, and have the possibility of long term cure, with 5 year survival rate ranging from 50% to 75% **[12]**.

For patients with multinodular HCC and relatively preserved liver function, absence of cancer-related symptoms, and no evidence of vascular invasion or extrahepatic spread at the time of presentation (ie, those classified as intermediate-stage according to the BCLC staging system), transcatheter arterial chemoembolization (TACE) is the current standard of care **[13]**.

Embolic microspheres that have the ability to release a drug in a controlled and sustained fashion have been shown to substantially increase the safety and efficacy of TACE in comparison to conventional ethiodized oil-based regimens.

Systemic treatment with the multikinase inhibitor sorafenib is recommended for patients with a more advanced stage of the disease **[14]**.

Recently, Y^{90} radioembolization has gained recognition as a locoregional treatment option for locally advanced HCC, primary and secondary liver tumors **[2]**. It is the delivery of radioactive microspheres containing Yttrium-90. The injected microspheres will reach the tumor area with selective production of high- energy, low-penetration radiation. Y^{90} radioembolization carries the advantage of the ability to perform it safely in patients with portal vein thrombosis owing to the minimally embolic effect of Y^{90} microspheres **[15]**.

Our study represents one of the earliest reports nationally to describe the effect and safety of Y^{90} radioembolization in locally advanced HCC.

Our study consisted of 9 patients with stage B and 11 patients with stage C HCC, according to BCLC staging system, with the patients with portal vein thrombosis (PVT) accounting for 55% of the study population.

That differs from the natural history of HCC, where only about 30% of the patient develops portal vein thrombosis during the course of the disease **[1]**.

This difference as caused by our selection-inclusion criteria-, as only cases of locally advanced disease were enrolled in the study.

Tumor response evaluation. Until now, there is no definite trusted tool for prediction of ^{Y90} radioembolization response, either in the pre-treatment phase or intra-procedure.

Tumor response was assessed using the conventional RECIST criteria, the rates of complete response, partial response, stable disease and disease progression for our study sample after 3 months were 0%, 55%, 30% and 10%, respectively while after 6 months it became 0, 50%, 20% and 25% respectively. This figures are lower than with the results announced by Philip et al., **[16]** where the partial response, stable disease and disease progression rates were 16%, 74%, and 10%, respectively. In this study, the overall response rate was 55%, compared to 90% in the aforementioned study.

When applying the mRECIST criteria for evaluation of tumor response, the rates changed to 10%, 55%, 20% and 10%, again, this was compared to Philip et al., 2010 **[16]** group, as their figures also changes to 6% complete responders, 35% partial responders, 48%. In this study, the overall response rate in our study became 65%, while in the aforementioned study it became 90%.

The measurable response rates in our study, were slightly lower than a study by Salem et al., 2010, **[2]** for report on long term outcomes after Y^{90} radioembolization. The explanation for this phenomenon may be that our cohort consisted of more advanced tumors with either large, multifocal, or diffusely infiltrating tumors or PVT. Although the radiological response rate in this cohort was not as high as other reports of liver-directed therapies (for example, radiofrequency ablation), it is important to recognize that this cohort did include patients with infiltrative and multifocal disease, large tumors, and PVT. These are generally excluded from other therapies (such as radiofrequency ablation), and hence a direct comparison of treatment response to these therapies is not possible. Larger tumors of the infiltrative type are unlikely to respond by size criteria.

The overall survival rate, Although ^{Y90} radioembolization has been shown to be effective in down-staging of HCC **[17]**., very few studies have shown overall survival benefit for patients treated with ^{Y90} radioembolization compared with transarterial chemoembolization **[2]**.

Liovet at al., **[14]** postulated that radiological response parameters and in particular TTP are believed to predict survival after locoregional therapy.

Philip et al., **[16]** did compare the results of his study about the safety and survival of HCC patients after Y90 radioembolization with the results of the phase III trial leading to approval of sorafenib (SHARP trial), the median overall survival in our HCC sample treated by ^{Y90} radioembolization was even slightly longer (16.4 months as compared to 10.7 months).

These data indicate that ^{Y90} radioembolization therapy requires further attention as a therapeutical option for the treatment of selected patients with advanced intrahepatic tumors, in particular with PVT and even in patients with limited extrahepatic disease.

Ando et al., **[18]**, reported an overall median survival of 306 days in 48 HCC patients with portal vein tumor thrombus treated with hepatic artery infusion chemotherapy. Such an approach does not lead to an embolic effect and thus may be a more appropriate comparable group to those treated with Y^{90} radioembolization.

Follow-up for this report was limited to 6 months with only two time points for objective response assessment. Later response and maximal response were not analyzed because of high variability in chronology and availability of follow-up. Molecular imaging tools such as PET may add to response assessment beyond anatomic changes only **[19]**, but these were available on only a few patients of our cohort.

Cost effectiveness. As the incidence of HCC continues to increase, costs associated with its detection, treatment, and complications are also expected to increase. ^{Y90} radioembolization and conventional transarterial chemoembolization are two known locoregional therapies in practice.

Nassir et al., **[20]**., conducted a study to cost-effectiveness analysis comparing ^{Y90} radioembolization with transarterial chemoembolization using a case-based design. They stated that ^{Y90} radioembolization is a more expensive treatment than transarterial chemoembolization.

The costs from the implementation of radioembolization include expenses related to:

1- ^{Y90} micospheres.

2- The evaluation performed before the procedure, which includes mapping angiography, a ^{99m}Tc-MAA scan to evaluate for the presence of a hepatopulmonary shunt.

3- Nuclear imaging studies.

4- The coil embolization of one or more GI arteries.

5- Two times pre-procedure laboratory and clinical assessment.
6- Two times IR suite expenses as well as the doubled expenses of the catheters, wires, microcatheters... etc.

In contrast, the costs involved with transarterial chemoembolization are related to the procedure itself and the associated overnight hospitalization, if needed.

Previous reports recommended mean interval for repeat of transarterial chemoembolization procedures being 10 months **[21]** and the maximum number of repeat trans-arterial chemoembolization procedures ranging from 4-10 procedures **[22]**.

So, one purported advantage of Y^{90} radioembolization is a need for fewer procedures than with transarterial chemoembolization. (Salem et al., 2011)

Nassir et al., **[20]**, hypothesized that patients with advanced liver disease, such as BCLC-C, may benefit from Y^{90} radioembolization, although at increased cost. However, patients with BCLC-A would not have a survival benefit from Y^{90} radioembolization.

Given the limited treatment options for patients with advanced disease, it becomes challenging to determine the best approach for patients, especially in an our country where health care expenses are of a major concern for both patients and health care providers.

A conclusion that maybe reached is that using Y90 radioembolization is not quite well justified by the current cost figures for all the different patient groups with HCC, and should be preserved for more advanced cases.

Limitations.

The findings from this study are encouraging but must be considered in the context of its limitations.

The small study sample was due to tight selection criteria, which were deemed necessary to create a homogeneous cohort.

The lack of control group-especially in cases with PVTT and financial constrictions remain as challenges.

Follow-up for this report was limited to 6 months with only two time points for objective response assessment. Later response and maximal response were not analyzed because of high variability in chronology and availability of follow-up.

Conclusion:

Y^{90} radioembolization is a potentially effective treatment option for intermediate and locally advanced cases of HCC. Future studies should be devoted to assessments of the role of Y^{90} radioembolization in the treatment algorithm for HCC.

Moreover, our data highlight the necessity for randomized controlled trials comparing and/or combining Y^{90} radioembolization with TACE in BCLC B patients and with systemic therapy in BCLC C patients.

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تقييم أمان علاج المراحل المتوسطة والمتقدمة - غير القابلة للإستئصال - من الأورام الكبدية الأولية بالحقن بالحبيبات المشعة عن طريق الشريان الكبدى

إن الحقن الكيميائى عن طريق القسطرة من خلال الشريان الكبدى هو العلاج المتاح الآن للمراحل المتوسطة من الأورام الأولية الكبدية، ولكن النتائج على المدى الطويل غير مرضية، كما أن الحقن الكيميائى يعتبر من الممنوعات الجزئية فى المراحل المتقدمة موضعياً.

وفى العقد الأخير، ظهر حقن الحبيبات المشعة عن طريق الشريان الكبدى– وهو يعتبر نوعاً من العلاج الأشعاعى الداخلى– كعلاج جديد لمثل هذه الحالات، حيث أوردت الكثير من التقارير والأبحاث تأثيره القوى على الأورام وإمكانية إستخدامه فى علاج هذه الحالات، حتى فى المرضى الذين يعانون من تدهور جزئى فى وظائف الكبد، إذا تم عمل التقييم المبدئى قبل العلاج بطريقة ملائمة.

وقد تطرق هذا البحث لإمكانية إستخدام العلاج بالحبيبات المشعة عن طريق الشريان الكبدى فى حالات الأورام الكبدية الأولية المتوسطة والمتقدمة موضعياً، كما تمت دراسة نجاحه، أمان هذه الطريقة الجديدة.

وقد جائت نتائجنا متوافقة مع الأبحاث المنشورة سابقاً والتى تبشر بنجاح هذه الطريقة.

ولكن يلزم المزيد من الوقت والعديد من الأبحاث المستقبلية لتحديد أفضل الطرق والتطبيقات وكذا المكان الأفضل لهذا العلاج بين أساليب العلاج الأخرى المستخدمة حالياً .