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A novel application of drug-eluting transarterial chemoembolization in treating non-liver cancers

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Abstract

This case series aimed to preliminarily evaluate the efficacy and safety of drug-eluting beads transarterial chemoembolization (DEB-TACE) in patients with lung, renal, gastric, and other non-liver cancers.

Twenty-four patients who underwent DEB-TACE or DEB-TACE combined with other therapies were reviewed in this case series. Treatment responses were assessed at 1 month after treatment according to the modified Response Evaluation Criteria in Solid Tumors. Overall survival (OS) and adverse events were recorded.

In the total patients, the objective response and disease control rate were 79.2% and 87.5%, respectively. And the mean OS in total patients was 14.7 months (95% confidence interval: 9.6–19.9 months). The number of patients who had generalized aches, nausea, vomit, fever, abdominal discomfort, chest discomfort, elevated blood pressure, cough, loss of appetite, and headache in total patients were 7 (29.2%), 11 (45.8%), 6 (25.0%), 2 (8.3%), 3 (12.5%), 3 (12.5%), 1 (4.2%), 1 (4.2%), 1 (4.2%), and 1 (4.2%), respectively. The objective response rates in patients with lung, renal, gastric, and other non-liver cancer were 70.0%, 85.7%, 100.0%, and 80.0%, respectively. In patients with lung, renal, gastric, and other non-liver cancers, the mean values of the OSs were 13.4 months, 12.4 months, 7.6 months, and 20.3 months, respectively. And the most common adverse events in lung cancer patients, renal carcinoma patients, gastric cancer patients, and patients with other non-liver cancers were post-embolization syndrome.

DEB-TACE may be an effective and safe therapeutic option in patients with lung, renal, gastric, and other non-liver cancers.

Abbreviations: CR = complete response, cTACE = conventional TACE, DCR = disease control rate, DEB-TACE = drug-eluting bead TACE, HCC = hepatocellular carcinoma, ORR = objective response rate, OS = overall survival, PD = progressive disease, PR = partial response, TACE = transarterial chemoembolization, TAI = transcatheter arterial infusion.

Keywords: drug-eluting beads transarterial chemoembolization, efficacy, gastric cancer, lung cancer, other cancer, renal carcinoma, safety

1. Introduction

Transarterial chemoembolization (TACE) is indicated as the first line therapy in hepatocellular carcinoma (HCC) patients at intermediate stage according to the Barcelona clinic liver cancer staging system. As one of the most promising type of TACE procedures, drug-eluting bead TACE (DEB-TACE) has shown many superiorities compared with conventional TACE (cTACE), including more sustained drug release, lower drug concentration in peripheral circulating system and simultaneously achieving embolization as well as tumor necrotic effect.[1] In addition, DEB-TACE also shows potential in treating HCC patients who were in early or advanced stages, and it is more encouraging that a few studies illuminate that DEB-TACE has the potential to be applied in patients with other solid tumors, such as unresectable soft tissue sarcoma and liver metastasis from other sites.[2–8]

Based on the most recent global epidemiology report of cancer, several carcinomas remain to be the major causes of cancer death, which include lung cancer, colorectal carcinoma, gastric cancer, and so on.[9] For the purpose of enhancing treatment response and prolonging survival of patients with these cancers, increasing studies have been done to explore optional treatment modalities. Since that HCC patients have benefited from the DEB-TACE treatment for decades, and DEB-TACE has shown potential in the management of other solid tumors, we hypothesized that

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DEB-TACE might also be efficient and tolerant in patients with other solid tumors. Therefore, this case series aimed to initially investigate the efficacy and safety of DEB-TACE in patients with lung, renal, gastric, and other non-liver cancers.

2. Materials and methods

2.1. Patients

The clinical data of 24 patients who underwent DEB-TACE or DEB-TACE combined with other therapies between April 2016 and August 2018 in The First Affiliated Hospital of Zhengzhou University were reviewed in this case series study. Enrolled disease types were all primary cancers, and the patients with history of other cancer or hematological malignancy except for their primary cancer were excluded from our study. The cancers in this study included lung cancer (n = 10), renal carcinoma (n = 7), gastric cancer (n = 2), tonsillar squamous cell carcinoma (n = 1), left lower extremity fusocellular sarcoma (n = 1), sacrococcygeal yolk sac tumor (n = 1), small bowel adenocarcinoma with uterine metastasis (n = 1) and bladder cancer (n = 1). All patients willingly underwent DEB-TACE or DEB-TACE combined with other treatments (such as cTACE, surgery, transcatheter arterial infusion [TAI]) according to the disease requirement. After obtaining approval from the Institutional Review Board of The First Affiliated Hospital of Zhengzhou University, verbal (with recording) or written informed consent was acquired from the patient or their guardians.

2.2. Data collection

The clinical data were collected from clinical records, which included disease type, age, gender, histological type, tumor location, number of tumors, tumor size, tumor-node-metastasis (TNM) stage, Eastern Cooperative Oncology Group score, treatment history, and treatment protocol. Besides, the operative procedures, adverse events, and the routine postoperative follow-up records were also retrospectively collected. The overall survival (OS) was calculated from the date of operation to the date of death or last visit.

2.3. Treatment

Patients received DEB-TACE or DEB-TACE combined with other treatments (such as cTACE, surgery, TAI) according to the clinical conditions. Microspheres used in the DEB-TACE were CalliSpheres microspheres (Jiangsu Hengrui Medicine Co., Ltd., Jiangsu Province, China), and the diameter of CalliSpheres microspheres ranged from 100 μm to 500 μm, which were loaded with chemotherapy drugs before initiation of the operation. Detailed DEB-TACE procedures were provided in the Supplementary Methods, http://links.lww.com/MD/E630.

2.4. Assessments of treatment response

Enhanced computerized tomographic scanning or magnetic resonance imaging examination was performed at 1 month after treatment, and the treatment response was evaluated according to the modified Response Evaluation Criteria in Solid Tumors, which were defined as follows:

(1) complete response (CR): disappearance of any intratumoral arterial enhancement in all target lesions;
(2) partial response (PR): at least a 30% decrease in the sum of diameters of viable (enhancement in the arterial phase) target lesions;
(3) stable disease: any cases that did not qualify either PR or progressive disease (PD);
(4) PD: an increase of at least 20% in the sum of the diameters of the viable (enhancing) target lesions.

In addition, objective response rate (ORR) was defined as CR + PR, and disease control rate (DCR) was defined as CR + PR + stable disease. Besides, subsequent therapies, such as repeated DEB-TACE, DEB-TACE combined with cTACE, TAI or surgery, were given patients according to the treatment response and disease status.

2.5. Statistical analysis

Data were displayed as mean (standard deviation) or count, count (percentage). Kaplan–Meier curves were plotted to display survival profiles using the GraphPad Prism 7.02 (GraphPad Software, La Jolla, CA).

3. Results

3.1. Patients characteristics

Twenty-four patients with lung, renal, gastric, and other non-liver cancers who received DEB-TACE or DEB-TACE combined with other therapies were analyzed in this case series. In 10 lung cancer patients, the mean age was 61.1 ± 8.6 years old and there were 7 males as well as 3 females (Table 1). There were 20 (83.3%) patients with new onset disease and 4 (16.7%) patients with relapsed disease among the total patients. The mean tumor size of lung cancer patients was 5.8 ± 2.9 cm. The number of patients in TNM stage I, II, III, and IV were 0 (0.0%), 1 (10.0%), 4 (40.0%), and 5 (50.0%), respectively. And the numbers of patients who were treated with DEB-TACE, DEB-TACE + cTACE, DEB-TACE + cTACE + TAI and DEB-TACE + cTACE + surgery were 5 (50.0%), 3 (30.0%), 2 (20.0%), and 0 (0.0%), respectively. In the 7 renal carcinoma patients, the mean age and the number of male and female were 69.9 ± 11.8 years old, 3 and 4, respectively. The mean value of tumor size was 7.9 ± 2.7 cm. There were respectively 2 (28.6%), 3 (42.9%), 0 (0.0%), and 2 (28.5) patients who were in TNM stage I, II, III, and IV, and there were 5 (50.0%) patients who were treated with DEB-TACE alone and 2 (28.6%) who were treated by DEB-TACE + cTACE. In the 2 gastric cancer patients, the mean age was 59.5 ± 6.4 years, and there were 1 male and 1 female patient with a mean tumor size of 5.7 ± 1.0 cm. Both 2 gastric cancer patients were treated with DEB-TACE alone. As for the 5 patients with other cancers, the mean age and the number of males and females were 52.8 ± 33.5 years old, 2 and 3, respectively. The mean tumor size was 5.2 ± 2.7 cm. Additionally, the numbers of patients with other cancers who were treated by DEB-TACE, DEB-TACE + cTACE, DEB-TACE + cTACE + TAI and DEB-TACE + cTACE + surgery were 3 (60.0%), 0 (0.0%), 1 (20.0%), and 1 (20.0%). Other information on baseline characteristics in patients was listed in Table 1.

3.2. Treatment response, survival, and adverse events in total patients

In the total 24 patients, no patients achieved CR at 1-month post DEB-TACE treatments, and the ORR as well as DCR were

Table 1

Baseline characteristics of patients.

Items	Lung cancer (n=10)	Renal carcinoma (n=7)	Gastric cancer* (n=2)	Other cancers† (n=5)
Age yr, mean (SD)	61.1 (8.6)	69.9 (11.8)	59.5 (6.4)	52.8 (33.5)
Gender, (male/female)	7/3	3/4	1/1	2/3
Histological type, No. (%)				
Adenocarcinoma	4 (40.0)	0 (0.0)	–	1 (20.0)
Squamous cell carcinoma	5 (50.0)	1 (14.3)	–	–
Cancer status				
New onset	9 (90.0)	6 (85.7)	2 (100.0)	3 (60.0)
Relapsed	1 (10.0)	1 (14.3)	0 (0.0)	2 (40.0)
Location of tumor, No. (%)				
Left	3 (30.0)	2 (28.6)	–	–
Right	5 (50.0)	3 (42.9)	–	–
Number of tumors, No. (%)				
1	9 (90.0)	6 (85.7)	2 (100.0)	5 (100.0)
2	1 (10.0)	1 (14.3)	0 (0.0)	0 (0.0)
Tumor size, cm, mean (SD)	5.8 (2.9)	7.9 (2.7)	5.7 (1.0)	5.2 (2.7)
TNM stage, No. (%)				
I	0 (0.0)	2 (28.6)	0 (0.0)	0 (0.0)
II	1 (10.0)	3 (42.9)	0 (0.0)	0 (0.0)
III	4 (40.0)	0 (0.0)	0 (0.0)	1 (20.0)
IV	5 (50.0)	2 (28.5)	2 (100.0)	4 (80.0)
ECOG score, No. (%)				
1	5 (50.0)	6 (85.7)	1 (50.0)	1 (20.0)
2	5 (50.0)	1 (14.3)	1 (50.0)	4 (80.0)
Previous treatment, No. (%)				
No	5 (50.0)	6 (85.7)	1 (50.0)	3 (60.0)
Surgical resection	1 (10.0)	1 (14.3)	0 (0.0)	2 (40.0)
Chemotherapy	2 (10.0)	0 (0.0)	1 (50.0)	0 (0.0)
Radiotherapy	1 (10.0)	0 (0.0)	0 (0.0)	0 (0.0)
Targeted therapy	1 (10.0)	0 (0.0)	0 (0.0)	0 (0.0)
Combined treatments				
DEB-TACE	5 (50.0)	5 (71.4)	2 (100.0)	3 (60.0)
DEB-TACE + cTACE	3 (30.0)	2 (28.6)	0 (0.0)	0 (0.0)
DEB-TACE + cTACE + TAI	2 (20.0)	0 (0.0)	0 (0.0)	1 (20.0)
DEB-TACE + cTACE + surgery	0 (0.0)	0 (0.0)	0 (0.0)	1 (20.0)

cTACE = conventional transarterial chemoembolization, DEB-TACE = drug-eluting bead transarterial chemoembolization, ECOG = Eastern Cooperative Oncology Group, SD = standard deviation, TAI = transcatheter arterial infusion, TNM = tumor-node-metastasis.

* Included a gastric cardia cancer.

† Others included tonsillar squamous cell carcinoma, fusocellular sarcoma, sacrococcygeal yolk sac tumor, small bowel adenocarcinoma with uterine metastasis and bladder cancer.

79.2% and 87.5%, respectively (Fig. 1). In addition, the mean OS in total patients was 14.7 months (95% confidence interval [CI]: 9.6–19.9 months) (Fig. 2A). As for adverse events post DEB-TACE treatments, the numbers of patients who had generalized aches, nausea, vomit, fever, abdominal discomfort, chest discomfort, elevated blood pressure (with a range of 147–179 mm Hg for systolic blood pressure and 91–107 mm Hg for diastolic blood pressure), cough, loss of appetite, and headache in total patients were 7 (29.2%), 11 (45.8%), 6 (25.0%), 2 (8.3%), 3 (12.5%), 3 (12.5%), 1 (4.2%), 1 (4.2%), 1 (4.2%), and 1 (4.2%), respectively (Table 2).

3.3. Treatment response, survival, and adverse events in lung cancer patients

The ORR and DCR in lung cancer patients post DEB-TACE treatments were 70.0% and 90.0%, respectively (Table 3), and the mean OS was 13.4 months (95% CI: 3.5–23.2 months) (Fig. 2B). In addition, the numbers of lung cancer patients who had generalized aches, nausea, vomiting, and fever post DEB-TACE were 1 (10.0%), 5 (50.0%), 3 (30.0%), and 1 (10.0%), respectively (Table 2). The other adverse events in lung cancer patients included 3 (30.0%) patients with chest discomfort, and 1 (10.0%) patient with a cough. The detailed information of the 10 lung cancer patients was displayed in Table 4.

3.4. Treatment response, survival, and adverse events in renal carcinoma patients

Post DEB-TACE treatments, the ORR and DCR in renal carcinoma patients were both 85.7% (Table 3). And the mean OS was 12.4 months (95%CI: 6.9–17.9 months) (Fig. 2C). In addition, there were respectively 3 (42.9%), 4 (57.1%), 1 (14.3%), 1 (14.3%), 2 (28.6%), 0 (0.0%), 1 (14.3%), 0 (0.0%), and 1 (14.3%) patients who had generalized aches, nausea, vomit, fever, abdominal discomfort, chest discomfort, elevated blood pressure (with a range of 147–179 mm Hg for systolic blood pressure and 91–107 mm Hg for diastolic blood pressure), cough, loss of appetite, and headache in renal carcinoma patients (Table 2). The detailed information about the 7 renal carcinoma patients could be seen in Table 4.

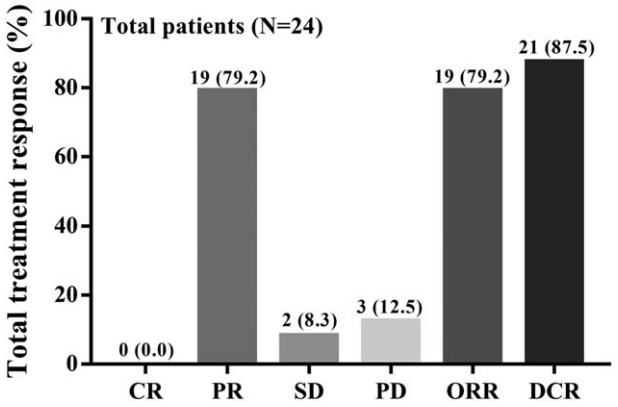

Figure 1. Total treatment response after DEB-TACE. The ORR and DCR were 79.2% and 87.5%, respectively in total patients. DCR = disease control rate, DEB-TACE = drug-eluting bead transarterial chemoembolization, ORR = objective response rate.

3.5. Treatment response, survival, and adverse events in gastric cancer patients

The ORR and DCR in 2 gastric cancer patients after DEB-TACE treatments were both 100.0% (Table 3), and patients had a mean OS of 7.6 months (95 CI: 7.6–7.6 months) (Fig. 2D). As for adverse event, there existed 1 (50.0%) patient who had nausea and 1 (50.0%) patient who presented with vomit post DEB-TACE (Table 2). The other detailed information of the 2 gastric cancer patients was listed in Table 4.

3.6. Treatment response, survival, and adverse events in patients with other cancers

In the 5 patients with other cancers, DEB-TACE treatments achieved an ORR of 80.0% and a DCR of 80.0% (Table 3), and the mean OS was 20.3 months (95% CI: 12.3–28.3 months) (Fig. 2E). Post DEB-TACE treatments, there were 3 (60.0%) patients who had generalized aches, 1 (20.0%) patient with nausea, 1 (20.0%) patient who was presented with vomit, and 1 (20.0%) who had abdominal discomfort (Table 2). Additionally, the comprehensive information of the 5 patients with other cancers was presented in Table 4.

4. Discussion

DEB-TACE not only achieves good efficacy and safety in HCC patients, but also presents with somewhat satisfying benefits in patients with other liver cancers, such as cholangiocarcinoma.[4,10–13] As for the application of DEB-TACE in non-liver cancers, the investigation is quite scarce. To the best knowledge of ours, this was the first case series that described the efficiency and tolerance of DEB-TACE in patients with non-liver cancers.

Lung cancer remains to occupy the first place of the most frequently diagnosed cancer and the leading cause of cancer-related death worldwide, and the 5-year survival rate of lung cancer patients is merely 4% to 17%.[9,14] Only the early stage non-small cell lung cancer patients are recommended as receivers of surgical resection with a relatively favorable survival post-surgery.[15] With respect to lung cancer patients at an advanced stage, although they have benefited from the existence of targeted

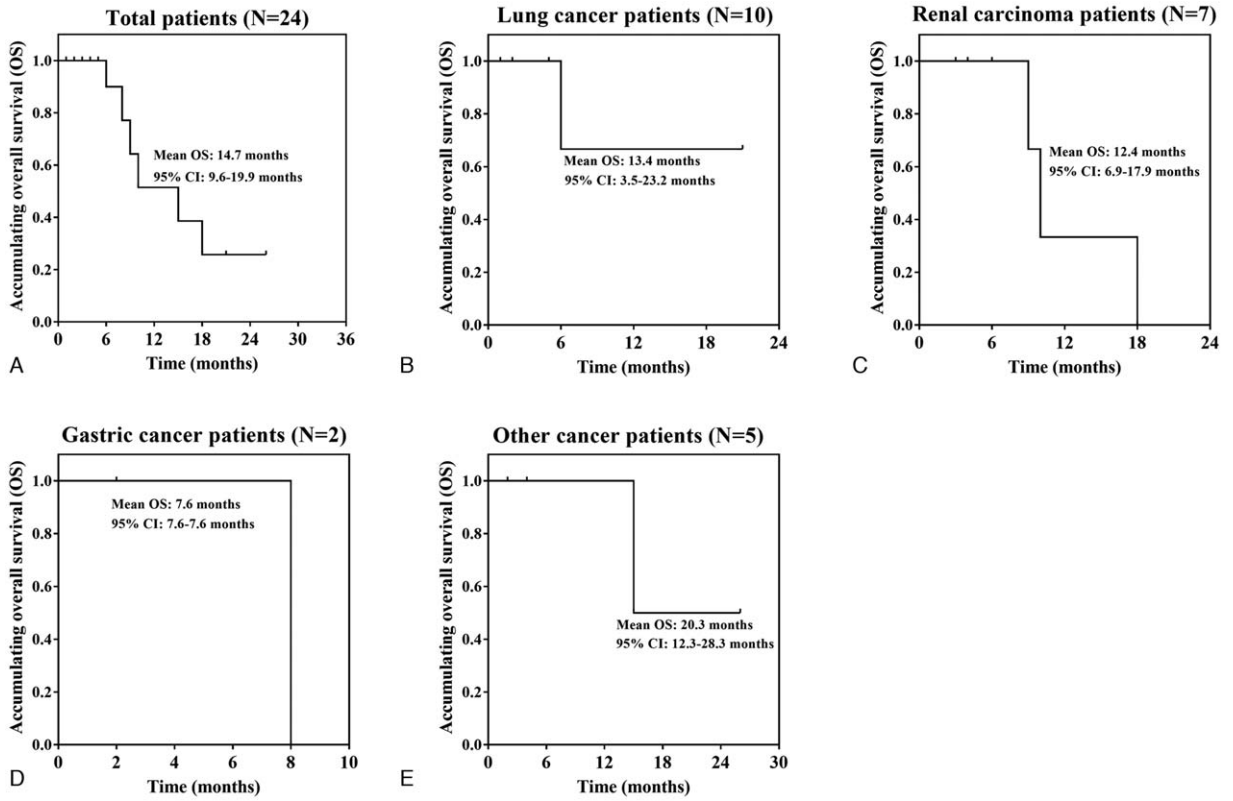

Figure 2. OS in total patients and patients with different cancers. The mean OS in total patients (A), lung cancer patients (B), renal carcinoma patients (C), gastric cancer patients (D) and patients with other cancer (D). Kaplan–Meier curves were plotted to display survival profiles. OS = overall survival.

Table 2

Adverse events.

Adverse events	Lung cancer (n = 10)	Renal carcinoma (n = 7)	Gastric cancer* (n = 2)	Other cancers† (n = 5)	Total
Generalized aches, No. (%)	1 (10.0)	3 (42.9)	0 (0.0)	3 (60.0)	7 (29.2)
Nausea, No. (%)	5 (50.0)	4 (57.1)	1 (50.0)	1 (20.0)	11 (45.8)
Vomit, No. (%)	3 (30.0)	1 (14.3)	1 (50.0)	1 (20.0)	6 (25.0)
Fever, No. (%)	1 (10.0)	1 (14.3)	0 (0.0)	0 (0.0)	2 (8.3)
Abdominal discomfort, No. (%)	0 (0.0)	2 (28.6)	0 (0.0)	1 (20.0)	3 (12.5)
Chest discomfort, No. (%)	3 (30.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (12.5)
Elevated blood pressure, No. (%)	0 (0.0)	1 (14.3)	0 (0.0)	0 (0.0)	1 (4.2)
Cough, No. (%)	1 (10.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (4.2)
Loss of appetite, No. (%)	0 (0.0)	1 (14.3)	0 (0.0)	0 (0.0)	1 (4.2)
Headache, No. (%)	0 (0.0)	1 (14.3)	0 (0.0)	0 (0.0)	1 (4.2)

DEB-TACE = drug-eluting bead transarterial chemoembolization.

* Included a gastric cardia cancer.

† Others included tonsillar squamous cell carcinoma, fusocellular sarcoma, sacrococcygeal yolk sac tumor, small bowel adenocarcinoma with uterine metastasis and bladder cancer.

drugs, there is still a proportion of patients who do not have a molecular target and can only receive maintenance therapy.[16] As a hopeful therapeutic method for prolonging the survival of liver cancer patients, TACE has been used in lung cancer patients as well, nonetheless, and the investigation is still very preliminary. A recent case report elucidates that a small cell lung cancer patient at extensive stage who is treated by cTACE using cisplatin due to liver metastasis and then 4 doses of nivolumab presents with a clinical benefit of prolonged survival, and the patient has PD until 15 months after treatment.[17] And another study reports that using DEB-TACE in 10 patients with advanced primary lung cancer who are complicated with hemoptysis improves the hemoptysis in all the patients, indicating that DEB-TACE could be used in the treatment of complications in lung cancer patients.[18] In our study, we found that the ORR and DCR in lung cancer patients receiving DEB-TACE were 70.0% and 90.0%, and the mean OS was 13.4 months, which indicated that DEB-TACE treatment was effective in delaying the progression of lung cancer patients. In addition, the most common adverse event in our study was post-embolization syndrome, and other adverse events include 3 cases with chest discomfort and 1 case with cough, which were caused by the cancer type.

Renal carcinoma results in 403, 262 new cases and 175, 098 related deaths in 2018, which is a solid tumor with a relatively high cure rate in early stage while an extremely poor survival in advanced stage.[19,20] The first line therapy for renal carcinoma patients in advanced stages is tyrosine kinase inhibitors, such as cabozantinib, however, there are several clinical trials illuminating that the tyrosine kinase inhibitors have no survival benefit in metastatic clear cell renal cell carcinoma patients compared with immunosuppressants.[21] In order to improve the renal carcinoma patients' survival, mounting studies are engaging in exploring new targeted drugs or optional treatment modalities, however, TACE, including DEB-TACE, has never been investigated in renal carcinoma patients. To the best knowledge of ours, this was the first study exploring the efficacy and safety of DEB-TACE in renal carcinoma patients, and in this study, the ORR and DCR were both 85.7% post treatments, and the mean OS was 12.4 months. As for adverse events, the most common ones were post-embolization syndrome, and the other adverse events were abdominal discomfort, elevated blood pressure, loss of appetite, and headache, which were relatively less. These data indicated that DEB-TACE might be efficient and safe in renal carcinoma patients, which could serve as an optional therapeutic modality in clinical practice.

As the sixth most common cancer and the third leading cause of cancer-related death, gastric cancer requires a large amount of effort in the exploration of novel therapeutic modalities due to that most patients are diagnosed at an advanced stage.[22] Compared with lung cancer and renal carcinoma, reports of TACE in treating the patients with gastric cancer are comparably more. A previous case report elucidates that a 67-year-old male with a type 3 tumor in the upper gastric body and multiple liver metastasis is treated by TACE followed by a regimen of paclitaxel plus ramucirumab, which displays possibility of prolonging the survival of the patient.[23] And a study comparing hepatectomy and palliative local treatments for gastric cancer patients with liver metastasis reveals that according to the propensity score

Table 3

Treatment response.

Treatment response	Lung cancer (n = 10)	Renal carcinoma (n = 7)	Gastric cancer* (n = 2)	Other cancers† (n = 5)	Total
CR, No. (%)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
PR, No. (%)	7 (70.0)	6 (85.7)	2 (100.0)	4 (80.0)	19 (79.2)
SD, No. (%)	2 (20.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (8.3)
PD, No. (%)	1 (10.0)	1 (14.3)	0 (0.0)	1 (20.0)	3 (12.5)
ORR, No. (%)	7 (70.0)	6 (85.7)	2 (100.0)	4 (80.0)	19 (79.2)
DCR, No. (%)	9 (90.0)	6 (85.7)	2 (100.0)	4 (80.0)	21 (87.5)

CR = complete response, DCR = CR+PR+SD disease control rate, DEB-TACE = drug-eluting bead transarterial chemoembolization, ORR = CR +PR, objective response rate, PD = progressive disease, PR = partial response, SD = stable disease.

* Included a gastric cardia cancer.

† Others included tonsillar squamous cell carcinoma, fusocellular sarcoma, sacrococcygeal yolk sac tumor, small bowel adenocarcinoma with uterine metastasis and bladder cancer.

Table 4

Detailed data of total patients.

No.	Age (yr)	Gender	Cancer	Tumor number	Tumor size (cm)	TNM stage	ECOG score	Previous treatment	Treatment protocols	No. of treatments in 6 mo	Response	Outcome	OS (mo)
1	73	Female	ccRCC	2	8.2	IV	2	Surgical resection	DEB-TACE + cTACE	2	PR	Death	9
2	65	Male	Lung squamous cell carcinoma (right)	1	6.0	IV	2	No	DEB-TACE	2	SD	Survival	1
3	59	Male	Lung adenocarcinoma (right)	1	7.1	III	2	Chemotherapy	DEB-TACE + cTACE + TAI	3	SD	Survival	2
4	71	Male	Lung squamous cell carcinoma (right)	1	3.4	II	1	No	DEB-TACE + cTACE	3	PR	Survival	21
5	42	Male	Tonsillar squamous cell carcinoma	1	1.2	III	2	No	DEB-TACE	3	PR	Survival	2
6	76	Female	Lower limb fusocellular sarcoma (left)	1	7.4	IV	2	No	DEB-TACE + cTACE + Surgery	2	PR	Death	15
7	67	Female	Lung adenocarcinoma (right)	1	8.3	III	1	No	DEB-TACE	3	PR	Survival	5
8	80	Female	Renal carcinoma (left)	1	7.3	II	1	No	DEB-TACE	2	PR	Survival	–
9	4	Female	Sacrococcygeal yolk sac tumor	1	6.0	IV	1	No	DEB-TACE	2	PD	Survival	4
10	67	Male	Lung squamous cell carcinoma	1	9.2	IV	2	Radiotherapy	DEB-TACE	1	PR	Death	6
11	51	Female	Small bowel adenocarcinoma with uterine metastasis	1	7.5	IV	2	Surgical resection	DEB-TACE + cTACE + TAI	3	PR	Survival	4
12	64	Male	Renal carcinoma (left)	1	9.2	II	1	No	DEB-TACE + cTACE	2	PR	Survival	3
13	72	Female	Renal carcinoma (right)	1	9.2	IV	1	No	DEB-TACE	2	PR	Death	10
14	80	Male	Renal pelvic carcinoma (right)	1	2.9	I	1	No	DEB-TACE	3	PR	Survival	6
15	58	Male	Lung squamous cell carcinoma (left)	1	8.8	III	2	Chemotherapy	DEB-TACE	2	PD	Survival	6
16	55	Male	Gastric adenocarcinoma	1	6.5	IV	2	No	DEB-TACE	2	PR	Survival	2
17	74	Female	Renal carcinoma (right)	1	7.1	I	1	No	DEB-TACE	2	PR	Survival	4
18	66	Male	Lung cancer	2	0.8	IV	2	Surgical resection	DEB-TACE	2	PR	Survival	1
19	64	Female	SCLC (left)	1	7.7	III	1	No	DEB-TACE + cTACE	2	PR	Survival	2
20	51	Female	Lung adenocarcinoma (right)	1	2.8	IV	1	Targeted therapy	DEBTACE + cTACE + TAI	3	PR	Survival	5
21	43	Male	Lung adenocarcinoma (left)	1	3.6	IV	1	No	DEB-TACE + cTACE	3	PR	Survival	5
22	46	Male	ccRCC	1	11.7	II	1	No	DEB-TACE	5	PD	Death	18
23	64	Female	Gastric cardia cancer	1	5.0	IV	1	Chemotherapy	DEB-TACE	1	PR	Death	8
24	91	Male	Bladder cancer	1	3.9	IV	2	Surgical resection	DEB-TACE	1	PR	Survival	26

ccRCC = clear cell renal cell carcinoma, CR = complete response, cTACE = conventional transarterial chemoembolization, DEB-TACE = drug-eluting bead transarterial chemoembolization, ECOG = Eastern Cooperative Oncology Group, OS = overall survival, PD = progressive disease, PR = partial response, SCLC = small cell lung cancer, SD = stable disease, TAI = transcatheter arterial infusion, TNM = tumor-node-metastasis.

matching analyses, TACE achieves a similar survival benefit in patients compared with RFA and requires markedly less average cost.[24] These studies all indicate a potential benefit of TACE in gastric cancer patients. However, to our best knowledge, there is still no study evaluating the efficacy and safety of DEB-TACE in gastric cancer, in this study, we only included 2 gastric cancer patients receiving DEB-TACE alone due to that the cases are sporadic in clinical practice, and both the 2 patients were treated with DEB-TACE alone. Post-treatment, both of the 2 gastric cancer patients achieved PR, and the mean OS of 7.6 months, and the adverse events were 1 case with nausea and 1 case with vomit, suggesting that DEB-TACE might be applicable in gastric cancer patients.

Furthermore, this case series also included 5 patients with other cancers, which consisted of tonsillar squamous cell cancer, lower limb fusocellular sarcoma, sacrococcygeal yolk sac tumor, small bowel adenocarcinoma, and bladder cancer. These cancers are united by pretty low incidence, and some of them are with very poor prognosis, such as tonsillar squamous cell carcinoma. The application of DEB-TACE in these cancers is pretty rare. A retrospective study reveals that 10 patients with unresectable sarcoma refractory to systemic chemotherapy receiving DEB-TACE present with a median survival of 21 months, 1- and 2-year OS rate of 90% and 30%, an ORR of 30.0% and a DCR of 70%, and no severe AE is found post-treatment; and the study concludes that DEB-TACE could serve as an optional treatment for unresectable soft tissue sarcoma refractory to conventionally systemic chemotherapy.[7] In our study, the patients with other cancers presented with an ORR and a DCR both of 80.0%, and a mean OS of 20.3 months, which indicated a satisfactory efficacy of DEB-TACE in these patients. Moreover, the vast majority of the patients with other cancers presented post-embolization syndrome, and only 1 patient had abdominal discomfort post-treatment, which suggested that DEB-TACE might also be tolerable in these patients.

What is more, in our study, various embolic agents are used, which consist of the polyvinyl alcohol agents (DEB) and conventional embolic agents (most of which were gelatin sponges). This might also affect the treatment efficacy, as there are already studies elucidating a better efficacy of DEB compared with TACE using lipiodol and conventional embolic agents.[25–27] However, these studies are all conducted in liver cancer patients but not other malignancies, therefore, the effect of embolic agents (both DEB and conventional embolic agents) on efficiency and safety in patients with cancers other than liver cancer should be evaluated in future studies with larger sample size. Moreover, complementary embolization is used in some of our patients (most of who have large tumors), which is also a factor influencing the efficacy that should be investigated in future studies.

There were still several limitations in this case series, which included

(1) this was a retrospective study, which might result in some information of patients' to be incomplete, such as response to previous treatment and medical history of patients;
(2) this study was conducted in a single center, which might cause selection bias;
(3) the follow up duration in this study was relatively short, thus the long term results were not observed;
(4) there were a few patients who had history of surgical resection in this study, which might be a confounding factor.

In conclusion, DEB-TACE may be an effective and safe therapeutic option for patients with lung, renal, gastric, and other non-liver cancer. However, the results need to be validated by prospective studies and clinical trials.

Author contributions

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