



# Efficacy and safety analysis of selective hepatic vein occlusion combined with arterial chemoembolization versus conventional transarterial chemoembolization in the treatment of hepatocellular carcinoma

Jiang Chang, Haochen Wang, Jian Li, Long Jin

Department of Interventional Radiology, Beijing Friendship Hospital, Capital Medical University, Beijing, China

**Contributions:** (I) Conception and design: L Jin; (II) Administrative support: L Jin; (III) Provision of study materials or patients: J Chang, H Wang; (IV) Collection and assembly of data: J Chang, H Wang; (V) Data analysis and interpretation: J Chang, J Li; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

**Correspondence to:** Dr. Long Jin, MD. Department of Interventional Radiology, Beijing Friendship Hospital, Capital Medical University, Yong'an Road 95, Beijing 100050, China. Email: jinlong@ccmu.edu.cn.

**Background:** Transarterial chemoembolization (TACE) is a non-radical treatment. How to improve the local response rate of tumor is the direction we have been exploring. The purpose of this study is to compare the efficacy and safety of occlusion-TACE (O-TACE) versus conventional TACE (C-TACE) in the treatment of patients with early to mid-stage hepatocellular carcinoma (HCC) of lesions being confined to the same hepatic venous drainage area.

**Methods:** In this study, 40 patients with HCC were prospectively enrolled and randomly assigned to the O-TACE and C-TACE groups, and the efficacy of all patients was assessed at 1, 2, and 3 months after the first treatment, and adverse events (AEs) occurring during the treatment period were also recorded.

**Results:** At 1, 2 and 3 months after the first treatment, patients in the O-TACE group had significantly better complete response (CR) rates (35% vs. 5%,  $P=0.04$ ; 50% vs. 15%,  $P=0.04$ ; 70% vs. 30%,  $P=0.02$ ) than those in the C-TACE group. The most common AE was abdominal pain, and the liver function indexes of patients in both groups returned to the baseline level at 1 month after the first treatment, and there was no statistically significant difference in the rate of AEs between the two groups.

**Conclusions:** O-TACE has a better CR rate and a favorable safety profile in patients with early to mid-stage HCC of lesions being confined to the same hepatic venous drainage area.

**Keywords:** Hepatocellular carcinoma (HCC); transarterial chemoembolization (TACE); balloon occlusion; efficacy and safety

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## Introduction

Hepatocellular carcinoma (HCC) ranks as the sixth most prevalent cancer and the third leading cause of cancer-related mortality globally as of 2020 (1). Transarterial chemoembolization (TACE) is the most commonly used method in the treatment of unresectable HCC, demonstrating a definitive survival advantage over

supportive care (2). Despite this, TACE is not curative and frequently necessitates multiple sessions to achieve desirable local tumor control. In recent years, more and more scholars have tried to update the chemotherapeutic agents, embolic materials and delivery methods to improve the efficiency of drug delivery and further improve the local control rate (3).

In the 1960s, pioneering attempts by Rousselot *et al.*

and Grossi *et al.* sought to occlude the hepatic venous outflow tract using a double-lumen balloon in the inferior vena cava prior to administering chemotherapeutic agents in the hepatic artery of adult mongrel dogs. Their findings indicated that this occlusion led to increased drug concentrations within the hepatic parenchyma, hepatic veins, lymph nodes, and thoracic ducts. However, they observed a reduction in pulse pressure variation and cardiac output volume approximately 10 minutes following occlusion, indicating that the technique was relatively invasive and potentially hazardous (4,5).

Kanazawa *et al.*, in 1993, refined this approach, employing a balloon catheter to selectively occlude the hepatic vein in swine models, which significantly enhanced the safety and reduced the complexity of the procedure. Their studies revealed that temporary segmental hepatic vein occlusion was well-tolerated for up to an hour in pigs. Perfusion imaging confirmed that this occlusion markedly increased perfusion in the occluded segments, while perfusion in the non-occluded liver segments decreased (6).

Subsequently, Hiraki *et al.* adapted Doppler ultrasound to monitor changes in intrahepatic hemodynamics following right hepatic vein occlusion in patients with hepatic

malignancies. They observed an increase in right hepatic artery flow velocity post-occlusion, alongside a decrease in portal flow velocity. Notably, the mean peak flow velocity within the right hepatic artery dropped or stabilized between 15 to 30 seconds after occlusion, then surged and plateaued between 75 to 90 seconds, ultimately reaching 1.5 to 2 times the pre-occlusion velocity (7).

In 2007, Lee *et al.* attempted hepatic artery chemoembolization with temporary occlusion of the hepatic veins in patients with HCC with hepatic arteriovenous shunt. The results of their study showed that temporary balloon occlusion of the hepatic vein in HCC with hepatic artery to hepatic vein shunt allowed completion of TACE using conventional method while preventing pulmonary complications (8).

Building upon Hiraki *et al.*'s insights (7), we hypothesized whether extending hepatic vein occlusion duration and incrementally administering chemotherapeutic agents or embolic materials through the hepatic artery might redistribute these agents more effectively within the hepatic parenchyma and tumor, potentially surpassing the local control effect of conventional TACE (C-TACE). We have designated this novel approach as occlusion-TACE (O-TACE). Consequently, our study aims to compare the efficacy and safety profiles of O-TACE and C-TACE. We present this article in accordance with the STROBE reporting checklist (available at <https://jgo.amegroups.com/article/view/10.21037/jgo-23-992/rc>).

### Highlight box

#### Key findings

- Occlusion-transarterial chemoembolization was able to achieve better complete response (CR) rates than conventional transarterial chemoembolization and did not increase the rate of corresponding adverse events.

#### What is known and what is new?

- Rousselot *et al.* and Grossi *et al.* demonstrated that occlusion of the hepatic venous outflow tract using a double-lumen balloon in adult mongrel dogs with simultaneous intrahepatic arterial injection of chemotherapeutic agents increased the concentration of drugs in the hepatic parenchyma, hepatic veins, lymph nodes, and thoracic ducts. Kanazawa *et al.*, in 1993, refined this approach, employing a balloon catheter to selectively occlude the hepatic vein in swine models, which significantly enhanced the safety and reduced the complexity of the procedure.
- We obtained a better CR rate than conventional hepatic artery chemoembolization by using balloon selective occlusion of the hepatic vein followed by embolization of the tumor-supplying artery in patients with hepatocellular carcinoma.

#### What is the implication, and what should change now?

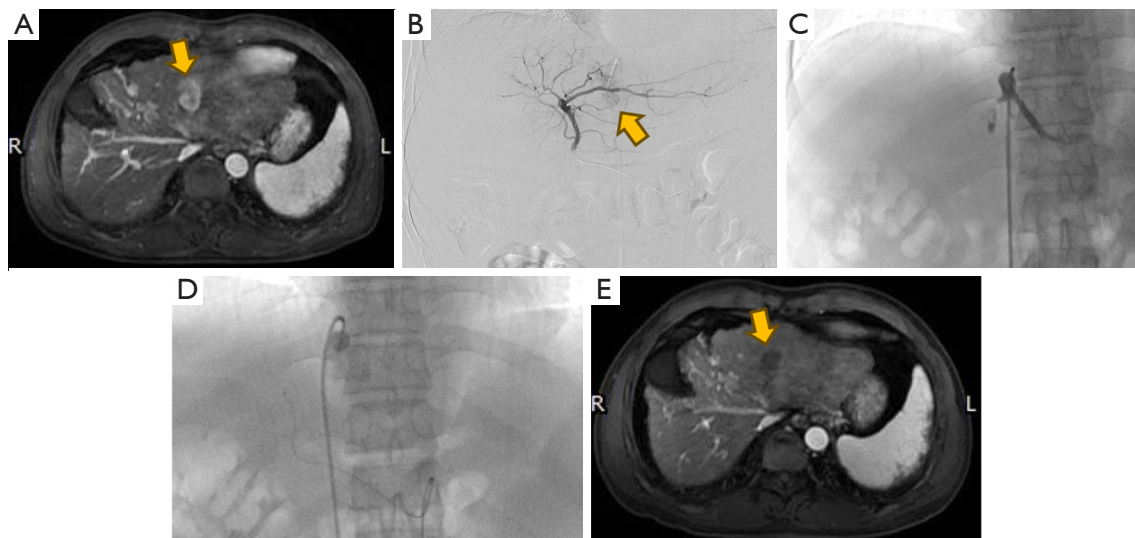
- This novel embolization modality achieves better local therapeutic response in patients with hepatocellular carcinoma in which the tumors being confined to the same hepatic venous drainage area.

## Methods

### Study population

This study included a total of 40 patients diagnosed with HCC in Beijing Friendship Hospital, who received initial treatment between August 2022 and March 2023. Patients were randomized into two groups, with 20 individuals each in the O-TACE and C-TACE groups.

Inclusion criteria included: (I) HCC confirmed via imaging or pathological diagnosis; (II) cases where the patient declined surgical intervention or where the tumor could not be completely resected; (III) lesions confined to the same hepatic venous drainage area, with no evidence of vascular invasion or extrahepatic metastasis; (IV) preserved liver function, categorized under Child-Pugh classes A and B; and (V) an Eastern Cooperative Oncology Group (ECOG) performance status ranging from 0 to 1. Exclusion criteria included: (I) irreversible coagulopathy; (II) current



**Figure 1** A 55-year-old patient with HCC was treated with O-TACE. (A) Preoperative MRI suggests a lesion in the left lobe of the liver (shown by the yellow arrow). (B) Stained nodular tumor seen on arteriography (shown by the yellow arrow). (C) Intraoperative TACE after balloon occlusion of the left hepatic vein. (D) Intraoperative chemotherapy drug infusion and embolization. (E) Repeat examination after 1 month of treatment showed complete tumor non enhancing (shown by the yellow arrow). HCC, hepatocellular carcinoma; O-TACE, occlusion-transarterial chemoembolization; MRI, magnetic resonance imaging; TACE, transarterial chemoembolization.

pregnancy or lactation; (III) previous targeted hepatic vein or portal vein occlusion procedures; and (IV) known allergies to iodine-based contrast agents. This study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Bioethics Committee of Beijing Friendship Hospital (No. 2022-P2-282-01). During the admission period of surgery, the registered patients provided written informed consent. During data collection, patient records were anonymous.

#### **O-TACE procedure**

Determination of the draining hepatic veins in the area of the lesion was based on methodologies from a previous study conducted by Murata *et al.* (9). Under local anesthesia, the right femoral artery and vein were accessed using the modified Seldinger technique. An 8-F guiding catheter and a 5.5-F Fogarty balloon catheter, guided by a guidewire, were inserted into the target hepatic vein to perform an angiogram. This angiogram was essential to confirm the patency of the vein, ensure the absence of stenosis, and verify that there were no significant veno-venous collateral shunts in the periphery. For the evaluation of vascular anatomy, tumor localization and extent, and portal venous flow patency, a 5-F angiography catheter was utilized to

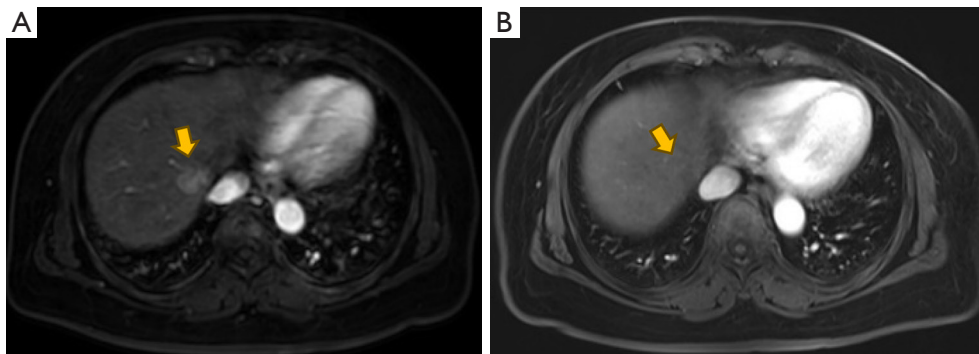
conduct angiograms of the common hepatic artery and superior mesenteric artery. Tumor-feeding arteries were then selectively catheterized using a 2.6-F microcatheter. Following the superselection, transcatheter arterial chemotherapy was administered. The protocol involved inflating the balloon, which was maintained in position for 2 minutes (*Figure 1*). The chemotherapy regimen selected was FOLFOX4. Concurrently, an emulsion was prepared by mixing piroxicam in a 1:2 ratio with iodized oil. The chemotherapy infusion was complemented by an embolization procedure using 300–500  $\mu\text{m}$  gelatin sponge particles, which was continued until blood flow stasis was achieved. Upon completion of the embolization, the balloon was deflated, and hepatic vein patency reassessed through repeat imaging.

#### **C-TACE procedure**

C-TACE was performed in the absence of hepatic vein occlusion according to the same procedure as describe in section “O-TACE procedure”.

#### **Follow-up**

Adverse events (AEs) were recorded for each patient within



**Figure 2** A 74-year-old female patient was treated with O-TACE (shown by the yellow arrows). (A) Tumor lesion located at the apex of the diaphragm near the inferior vena cava. (B) Disappearance of tumor lesion enhancing seen on follow-up after one treatment session (shown by the yellow arrow). O-TACE, occlusion-transarterial chemoembolization.

1 month post-procedure. These events were evaluated using the Common Terminology Criteria for Adverse Events version 4.0, focusing primarily on the identification of treatment-related adverse reactions. Biochemical parameters, including alanine aminotransferase (ALT), aspartate aminotransferase (AST), total bilirubin (TBILI), albumin (ALB), cholinesterase (CHE), and white blood cell count (WBC), were documented before treatment and 1 month post-operatively. At the one-month mark following the initial treatment, patients underwent dynamic-enhanced computed tomography (CT) or magnetic resonance imaging (MRI) (Figure 2). The MRI and CT scans were independently reviewed blindly by two experienced radiologists, each with more than five years of expertise. Tumor responses were evaluated according to the modified Response Evaluation Criteria in Solid Tumors (mRECIST) (10). A complete response (CR) was characterized by the complete disappearance of arterial enhancement in the target lesion. A partial response (PR) was defined as a reduction of greater than 30% in the sum of the diameters of viable (enhancing) lesions. Progressive disease (PD) was identified by an increase of over 20% in the sum of the diameters of viable lesions. Stable disease (SD) was determined as any instance that did not meet the criteria for PR or PD. The objective response rate (ORR) was calculated as the proportion of patients who achieved either a CR or PR. Overall survival (OS) was calculated from the commencement of TACE therapy to the date of death or loss to follow-up. Progression-free survival (PFS) was defined as the duration from the start of therapy until the progression of the liver tumor, lymph node metastases,

or the emergence of distant metastasis.

### Statistical analysis

All statistical analyses were performed using SPSS 22.0 (IBM Corporation, Armonk, NY, USA). Quantitative data were reported as the mean  $\pm$  standard deviation (SD) and were compared between these two groups using continuity correction and the independent-samples *t*-test, Pearson's  $\chi^2$  test, and Fisher's exact test. Categorical data were compared using the  $\chi^2$  test. The Kaplan-Meier method and log-rank test were used to estimate and compare PFS and OS, respectively, and corresponding 95% confidence intervals (CIs) were reported. All P value calculations were two sided, and  $P < 0.05$  was considered statistically significant.

## Results

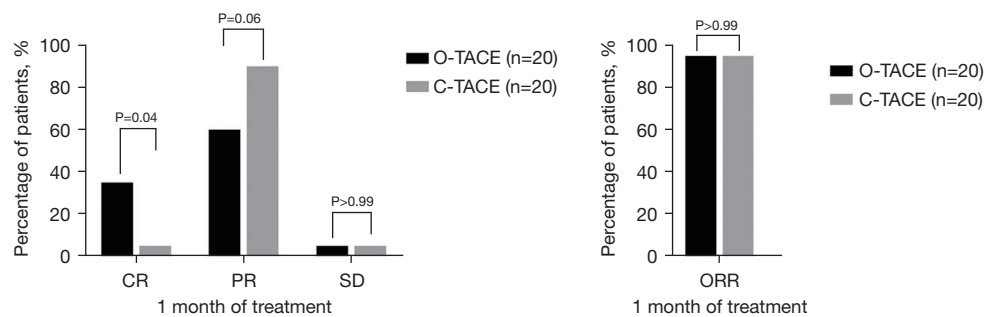
### Patients characteristics

In this study, a total of 40 patients were enrolled and randomly allocated into two groups: one to receive O-TACE treatment ( $n=20$ ) and the other to receive C-TACE treatment ( $n=20$ ). The mean age ( $\pm$  SD) of patients in the O-TACE group was  $61.9 \pm 9.6$  years, compared with  $66.9 \pm 6.7$  years in the C-TACE group. There were 11 (55%) and 6 (30%) patients who were chronic viral hepatitis B in the O-TACE and C-TACE groups, respectively. There were 14 (70%) cirrhotic patients in the O-TACE group compared to 11 (55%) in the C-TACE group. The median maximum tumor size of patients in the O-TACE and C-TACE groups were 3.6 and 3.2, respectively. The

**Table 1** Baseline characteristics of the patients

Characteristics	O-TACE (n=20)	C-TACE (n=20)	P value
Age, years	61.9±9.6	66.9±6.7	0.06
Sex (male/female)	15/5	16/4	>0.99
HBV/none	11/9	6/14	0.20
Cirrhosis/none	14/6	11/9	0.51
PIVKA-II, mAU/mL	119.3 [31.9, 412.6]	275.9 [52.6, 597.3]	0.26
AFP, ng/mL	9.0 [4.1, 329.1]	21.5 [2.2, 207.8]	0.86
Maximum tumor size, cm	3.6 [2.6, 6.2]	3.2 [2.6, 6.2]	0.87
Tumor number	1 [1, 4]	1 [1, 1]	0.05
BCLC stage (A/B)	12/8	15/5	0.31

Data are presented as mean ± standard deviation, number, or median [interquartile range]. O-TACE, occlusion-transarterial chemoembolization; C-TACE, conventional transarterial chemoembolization; HBV, hepatitis B virus; PIVKA-II, Protein Induced by Vitamin K Absence or Antagonist II; AFP, alpha-fetoprotein; BCLC, Barcelona Clinic Liver Cancer.



**Figure 3** CR, PR, SD and ORR evaluating by mRECIST in O-TACE group and C-TACE group at 1 month after treatment. CR, complete response; PR, partial response; SD, stable disease; O-TACE, occlusion-transarterial chemoembolization; C-TACE, conventional transarterial chemoembolization; ORR, objective response rate; mRECIST, modified Response Evaluation Criteria in Solid Tumors.

baseline characteristics of the two groups were compared, with no statistically significant differences observed (Table 1).

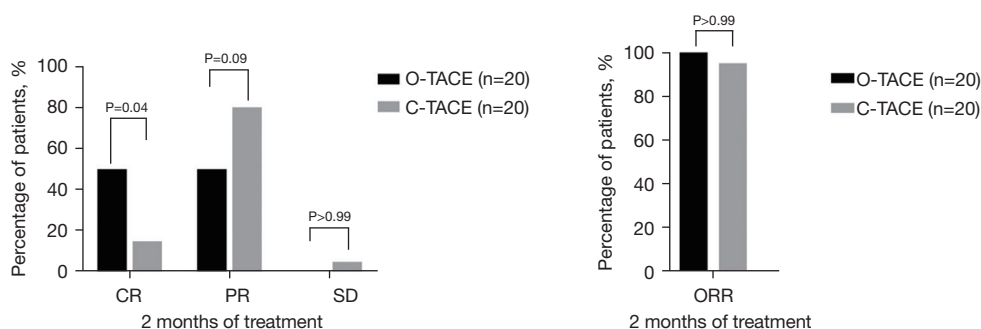
### Tumour response and time to tumor progression

Tumor response assessment was conducted by at least two experienced radiologists using the mRECIST. At 1 month post-therapy, the CR rate was higher in the O-TACE group compared to the C-TACE group (35% vs. 5%,  $P=0.04$ ). No significant differences were observed in PR rate, SD and overall response rate (ORR) between the two groups (Figure 3).

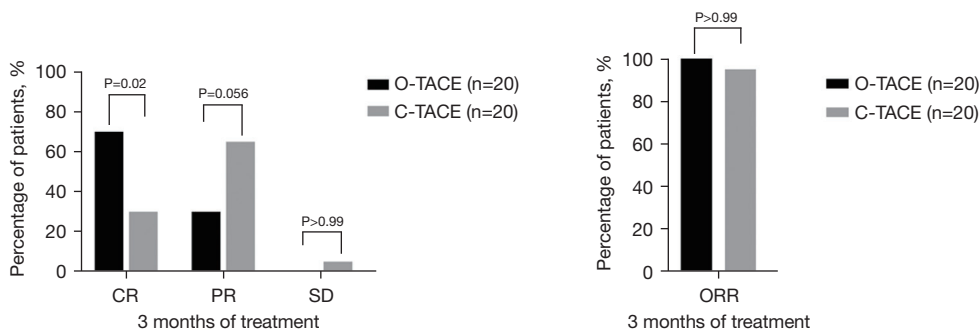
Furthermore, tumor response rates at 2 and 3 months following consecutive treatments were also evaluated. The CR rates in the O-TACE group were progressively and

significantly higher than those in the C-TACE group (50% vs. 15%,  $P=0.04$ ; 70% vs. 30%,  $P=0.02$ ) (Figures 4, 5). The levels of the liver tumor markers were notably decreased in O-TACE group, with a reduction of 48.9% ( $P=0.01$ ) in alpha-fetoprotein (AFP) and 72.4% ( $P=0.04$ ) in Protein Induced by Vitamin K Absence or Antagonist II (PIVKA-II). Similar but non-significant downturn was also observed in the C-TACE group (Table 2). Subgroup analysis indicated that O-TACE was a predictor of achieving a CR outcome 1 month after treatment (Table 3). Both groups showed a significant reduction in tumor diameter at 1 month post intervention compared to pre-surgical measurements (Figure 6).

During the follow-up period, neither group reached the median PFS, and no significant difference in PFS was



**Figure 4** CR, PR, SD and ORR evaluating by mRECIST in O-TACE group and C-TACE group at 2 months after treatment. CR, complete response; PR, partial response; SD, stable disease; O-TACE, occlusion-transarterial chemoembolization; C-TACE, conventional transarterial chemoembolization; ORR, objective response rate; mRECIST, modified Response Evaluation Criteria in Solid Tumors.



**Figure 5** CR, PR, SD and ORR evaluating by mRECIST in O-TACE group and C-TACE group at 3 months after treatment. CR, complete response; PR, partial response; SD, stable disease; O-TACE, occlusion-transarterial chemoembolization; C-TACE, conventional transarterial chemoembolization; ORR, objective response rate; mRECIST, modified Response Evaluation Criteria in Solid Tumors.

**Table 2** Tumor markers at 1 month after the first therapy for the two groups

Parameters	O-TACE (n=20)			C-TACE (n=20)		
	Baseline	After	P value	Baseline	After	P value
AFP, ng/mL	9.0 (4.1, 329.1)	4.6 (2.7, 196.7)	0.01	21.5 (2.2, 207.8)	4.1 (1.9, 94.1)	0.41
PIVKA-II, mAU/mL	119.3 (31.9, 412.6)	32.9 (11.9, 333.5)	0.04	275.9 (52.6, 597.3)	58.3 (29.1, 282.7)	0.05

Data are presented as median (interquartile range). O-TACE, occlusion-transarterial chemoembolization; C-TACE, conventional transarterial chemoembolization; AFP, alpha-fetoprotein; PIVKA-II, Protein Induced by Vitamin K Absence or Antagonist II.

observed between the groups (Figure 7).

**Safety analysis**

Postoperative AEs were recorded for all patients, with all incidents classified as grade 1–2 AEs. Notably, no AEs associated with hepatic vein occlusion were reported. Abdominal pain was among the most prevalent AEs, occurring in 60% of patients in the O-TACE group and

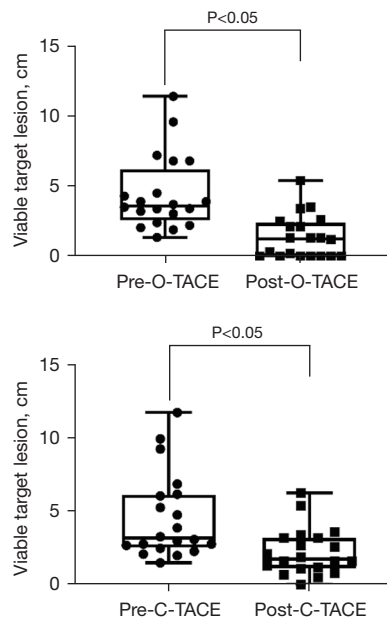
65% in the C-TACE group (P=0.74). Additional AEs are listed in Table 4. Statistical analysis revealed no significant difference in the incidence of AEs between the two treatment groups.

Alterations in baseline liver function indices 1 month postoperatively were also monitored. In the O-TACE group, levels of ALT, AST, and ALB were observed to be lower 1 month after the procedure compared to baseline; whereas, in the C-TACE group, only AST levels

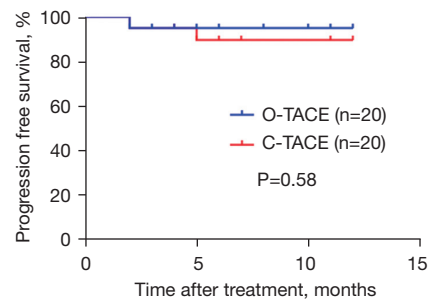
**Table 3** Subgroup analysis of 1-month CR

Variables	Univariate analysis	
	HR (95% CI)	P value
Age (>60 years)	1.462 (0.309–6.921)	0.63
Sex (male)	0.852 (0.144–5.032)	0.86
Maximum tumor size (>3 cm)	1.320 (0.263–6.635)	0.73
Tumor number (multiple)	4.200 (0.459–38.445)	0.20
Cirrhosis	0.487 (0.085–2.800)	0.42
BCLC (B)	4.200 (0.459–38.445)	0.20
PIVKA-II (>60 mAU/mL)	0.636 (0.110–3.694)	0.61
AFP (>600 ng/mL)	0.764 (0.358–7.625)	0.86
O-TACE/C-TACE	10.231 (1.121–93.341)	0.03

CR, complete response; HR, hazard ratio; CI, confidence interval; BCLC, Barcelona Clinic Liver Cancer; PIVKA-II, Protein Induced by Vitamin K Absence or Antagonist II; AFP, alpha-fetoprotein; O-TACE, occlusion-transarterial chemoembolization; C-TACE, conventional transarterial chemoembolization.

**Figure 6** Change in viable target lesion size after the first treatment. O-TACE, occlusion-transarterial chemoembolization; C-TACE, conventional transarterial chemoembolization.

were reduced at the one-month postoperative mark in comparison to baseline values (Table 5). The levels of the liver function indices were notably decreased in O-TACE group, with a reduction of 29.0% (P=0.005) in ALT

**Figure 7** Kaplan-Meier curves of PFS in HCC patients who underwent O-TACE or C-TACE. O-TACE, occlusion-transarterial chemoembolization; C-TACE, conventional transarterial chemoembolization; PFS, progression-free survival; HCC, hepatocellular carcinoma.**Table 4** AEs assessment after 1<sup>st</sup> therapy of two groups

AEs	O-TACE (n=20)	C-TACE (n=20)	P value
Fever	7 (35%)	5 (25%)	0.49
Abdominal pain	12 (60%)	13 (65%)	0.74
Vomiting	4 (20%)	3 (15%)	>0.99
Fatigue	2 (10%)	3 (15%)	>0.99

AEs, adverse events; O-TACE, occlusion-transarterial chemoembolization; C-TACE, conventional transarterial chemoembolization.

and 23.2% (P=0.02) in AST. Similar but non-significant downturn was also observed in the C-TACE group. No significant differences were detected in the comparison of individual liver function indices and leukocyte change rates post-treatment between the two patient groups (Figure 8).

## Discussion

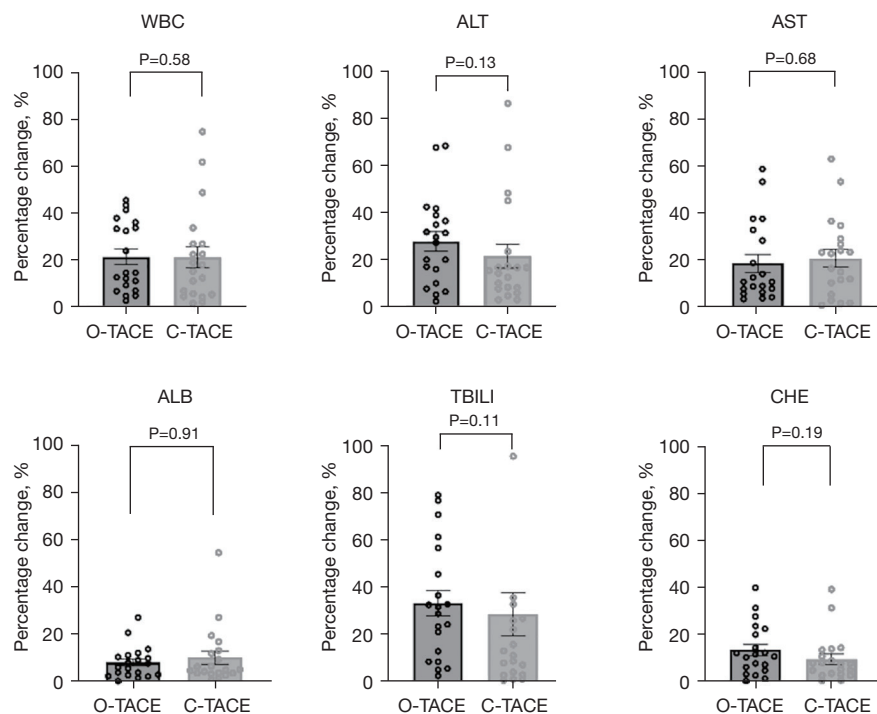
This study was designed to preliminarily investigate the efficacy and safety of O-TACE compared with C-TACE in patients with early to mid-stage HCC confined to a single liver lobe.

In our cohort, at 1 month postoperatively, patients in the O-TACE group achieved a CR rate of 35% vs. 5% in the C-TACE group. The ORR was comparable between the two groups, which implies that O-TACE may facilitate achieving a CR under similar conditions. Furthermore, at 2 and 3 months following consecutive treatments, the CR rate in the O-TACE group was consistently and significantly higher than in the C-TACE group. In our study the CR

**Table 5** Liver function changes 1 month after the first therapy for the two groups

Parameters	O-TACE (n=20)			C-TACE (n=20)		
	Baseline	After	P value	Baseline	After	P value
ALT, U/L	34.5 (5.3, 46.3)	24.5 (4.8, 36.5)	0.005	20.5 (13.0, 30.8)	15.0 (1.5, 31.3)	0.31
AST, U/L	36.7±17.1	28.2 (9.9, 36.9)	0.02	29.0 (23.2, 40.2)	24.4 (8.8, 35.7)	0.01
TBILI, μmol/L	21.5±10.1	22.5±11.6	0.57	20.9±9.1	19.9 (15.9, 24.9)	0.65
ALB, g/L	38.3±3.7	35.9±4.3	0.004	38.3±4.7	38.7±8.6	0.78
CHE, KU/L	5.9±1.7	5.7 (4.5, 6.7)	0.16	6.1±2.0	5.8±2.0	0.37
WBC, 10 <sup>9</sup> /L	5.6±1.6	5.3±1.7	0.45	4.8±2.2	4.2±1.7	0.08

Data are presented as median (interquartile range) or mean ± standard deviation. O-TACE, occlusion-transarterial chemoembolization; C-TACE, conventional transarterial chemoembolization; ALT, alanine aminotransferase; AST, aspartate aminotransferase; TBILI, total bilirubin; ALB, albumin; CHE, cholinesterase; WBC, white blood cell count.



**Figure 8** Changes in WBC and liver function indexes at 1 month after the first treatment. WBC, white blood cell count; ALT, alanine aminotransferase; AST, aspartate aminotransferase; ALB, albumin; TBILI, total bilirubin; CHE, cholinesterase; O-TACE, occlusion-transarterial chemoembolization; C-TACE, conventional transarterial chemoembolization.

rate of patients in the C-TACE group was lower than that of previous studies, which may be due to the possible selective bias of fewer patients enrolled in this study on the one hand, and the inclusion of some patients with multiple nodes in this study on the other hand. In the context of recent advancements, novel embolization techniques such as balloon-assisted TACE (B-TACE) and microsphere-

enhanced TACE (M-TACE) have been introduced with the aim of improving local response in HCC patients (11,12). Research by Kim *et al.* indicates that patients with an initial CR exhibit the longest OS, notably comparing to those who achieve a CR after multiple sessions or who attain a PR as their best outcome (13). In early to mid-stage HCC, the superior prognosis of combining TACE with ablation over



either modality alone has been well-documented (14-16). A single treatment replicating the effects of combination therapy would not only alleviate patient discomfort but also lessen the financial burden, aligning with the principles of refined TACE (17,18).

Our study acknowledges that while HCC predominantly derives its blood supply from the hepatic artery, smaller tumors also receive partial supply from the portal vein, and the blood supply from hepatic artery is increasing with tumor size (19). For extracapsular invasive areas, well-differentiated tumors, and satellite nodules, the supply from the portal vein via sinusoidal pathways is crucial. Consequently, blocking only the intra-tumoral hepatic arterial flow is insufficient for complete tumor necrosis (20). Temporary occlusion of the hepatic vein raises sinusoidal pressure, potentially reducing or reversing local portal flow, thereby enhancing local drug concentration and embolization density during transarterial embolization (6). Dense iodized oil deposition, a key predictor for achieving CR post-TACE, is closely linked to tumor necrosis (21-23).

Safety-wise, the rate of AEs did not significantly differ between the two groups, and notably, there were no events related to hepatic vein occlusion in the O-TACE group. The most common AE was abdominal pain, aligning with prior studies (12,24-26). Liver function in both groups returned to baseline levels 1 month post-surgery, with the O-TACE group displaying a significant reduction in transaminases from baseline, confirming the safety of O-TACE for HCC treatment.

However, limitations of the present study include the small sample size which may impart statistical bias and the short follow-up period, where neither patient group reached median PFS or OS. Granito *et al.* demonstrated that it is possible to predict the local response rate of postoperative lesions by analyzing changes in transaminases after TACE. However, in our study, we only collected preoperative and 1 month postoperative transaminase changes, which did not provide a predictive value for the local response rate of the patients, and we will study the method of Granito *et al.* to investigate the effect of transaminases on the local response rate of the patients with O-TACE in a subsequent study (27). If we can collect serum parameters of patients before treatment, 1 week after treatment, and 1 month after treatment, we can also use line charts to describe the trend more clearly as in the study of Kim *et al.* (28). These aspects necessitate further exploration. Studies on the hemodynamic and molecular biological mechanisms following local hepatic vein balloon occlusion are ongoing,

and the potential of this new embolization approach will be better understood once our related research series is complete.

## Conclusions

O-TACE offers a superior CR rate compared to C-TACE in patients with early to mid-stage HCC limited to a single hepatic lobe, without increasing AEs. Thus, O-TACE emerges as a viable and effective treatment alternative for such HCC patients.

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## Footnote

*Reporting Checklist:* The authors have completed the STROBE reporting checklist. Available at <https://jgo.amegroups.com/article/view/10.21037/jgo-23-992/rc>

*Data Sharing Statement:* Available at <https://jgo.amegroups.com/article/view/10.21037/jgo-23-992/dss>

*Peer Review File:* Available at <https://jgo.amegroups.com/article/view/10.21037/jgo-23-992/prf>

*Conflicts of Interest:* All authors have completed the ICMJE uniform disclosure form (available at <https://jgo.amegroups.com/article/view/10.21037/jgo-23-992/coif>). The authors have no conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. This study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Bioethics Committee of Beijing Friendship Hospital (No. 2022-P2-282-01). During the admission period of surgery, the registered patients provided written informed consent.

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