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ORIGINAL ARTICLE

TAE an alternative to TACE in developing countries: a 5-year retrospective, descriptive study in a single center

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Abstract

Background: *Transarterial embolization (TAE) is an alternative locoregional therapy for hepatocellular carcinoma (HCC), particularly in intermediate stages.* **Objective:** *To evaluate the radiological objective response rate (ORR), overall survival (OS) over three years, and procedure costs of TAE at our institution.* **Method:** *A retrospective cohort of patients with HCC treated with TAE between January 2016 and 2021 was analyzed. ORR was determined using multiphasic CT and MRI according to modified RECIST criteria. OS was calculated at 1 and 3 years, censored at death or last follow-up. Clinical, imaging, and procedural cost data were collected.* **Results:** *Thirty patients were included: 9 with Child-Pugh (CP) class A, 19 with CP class B, and 2 without cirrhosis. Before TAE, 21 patients (70%) were Barcelona Clinic Liver Cancer stage B and 9 (30%) stage A. The ORR to TAE was 76%. OS rates at 1 and 3 years were 66.7 and 36.7%, respectively, with a median survival of 26.8 months (95% CI: 13.3–not estimable). The mean cost per TAE was USD 2,870.* **Conclusion:** *TAE achieved ORR and OS outcomes comparable to TACE but at lower cost, supporting its role as a viable treatment option for unresectable HCC in resource-limited settings.*

Keywords: *Hepatocellular carcinoma. Transarterial embolization. Objective response rate. Overall survival. Costs transarterial embolization.*

ETA como alternativa a QETA en países en desarrollo: un estudio retrospectivo y descriptivo de cinco años en un solo centro

Resumen

Antecedentes: *La quimioembolización transarterial (QETA) es una modalidad terapéutica clave en el carcinoma hepatocelular (CHC), especialmente en estadios intermedios. En nuestra institución se empleó la embolización transarterial (ETA) y se compararon los resultados con los reportados en la literatura.* **Objetivo:** *Evaluar la tasa de respuesta objetiva radiológica (ORR), la supervivencia global (SG) a tres años y los costos asociados al procedimiento de ETA.* **Método:** *Estudio de cohorte retrospectivo que incluyó pacientes con CHC sometidos a ETA entre enero de 2016 y 2021. La ORR se determinó mediante tomografía y resonancia magnética multifásica según criterios mRECIST. La SG se estimó a 1 y 3 años, con censura en defunción o última visita. Se recolectaron datos clínicos, radiológicos y costos por procedimiento.* **Resultados:** *Se analizaron*

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30 pacientes: 9 con Child-Pugh A, 19 con B y 2 sin cirrosis. Según la clasificación BCLC, 70% correspondió a estadio B y 30% a estadio A. La ORR fue del 76%. La SG a 1 y 3 años fue del 66.7 y 36.7%, respectivamente, con mediana de 26.8 meses. El costo promedio por ETA fue de 2,870 USD. **Conclusiones:** *La ETA mostró ORR y SG comparables con la QETA, con menor costo, posicionándose como alternativa locorregional viable para CHC irresecable en entornos con recursos limitados.*

Palabras clave: *Carcinoma hepatocelular. Embolización transarterial. Tasa de respuesta objetiva. Supervivencia global. Costos.*

Introduction

Hepatocellular carcinoma (HCC) is the sixth most common cancer worldwide and ranks as the third leading cause of cancer-related death. It is the most prevalent primary malignant liver tumor, posing unique challenges in Mexico, where its incidence is rising. Among patients with cirrhosis, HCC is the leading cause of mortality, complicating the clinical landscape even further. Curative options for early-stage HCC include resection and liver transplantation, but fewer than 30% of patients are eligible. Moreover, recurrence rates remain high (50-70% within 2-5 years), and limited donor availability along with patient comorbidities often restrict the possibility of liver transplantation[1-4].

The Barcelona Clinic Liver Cancer (BCLC) staging system is the primary algorithm for treating HCC in Western medicine, endorsed by the European Association for the Study of the Liver (EASL) and the American Association for the Study of Liver Diseases[5]. It guides various treatments based on disease stage: surgical resection, liver transplantation, and local ablation for early-stage (BCLC A); transarterial therapies such as TAE and TACE for intermediate-stage (BCLC B); and systemic therapies for advanced-stage disease. Current international guidelines favor TACE over TAE as the preferred endovascular therapy[5-7].

Locoregional endovascular therapies are critical in managing 50-60% of HCC cases, serving palliative purposes. They can be used to improve the disease stage, allowing access to more curative treatments[5-7]. TAE occludes the tumor's arterial supply using embolic materials such as gelatin foam, Embospheres, microspheres, or microparticles. TACE, on the other hand, combines chemotherapeutic agents such as doxorubicin or cisplatin mixed with Lipiodol, followed by embolization. The benefit of adding chemotherapy remains debated, with studies suggesting that TAE and TACE provide similar overall survival (OS) in patients unsuitable for surgical resection[8,9].

TACE remains the most standardized and extensively studied endovascular therapy for HCC and is currently considered the gold standard for the treatment of intermediate-stage HCC, as endorsed by international guidelines[8-10]. However, the added value of incorporating chemotherapy into embolization remains controversial. Several randomized controlled trials, along with recent meta-analyses by Roth et al. and a study by Brown et al., have demonstrated no significant differences in OS, progression-free survival (PFS), transplant-free survival, or incidence of adverse events when compared to transarterial embolization (TAE) alone[11,12]. Although TACE has been associated with higher rates of complete radiological response, this has not translated into improvements in overall objective response or survival outcomes. Moreover, TACE is generally more expensive than TAE, although direct comparative cost data remain scarce in the current literature[9,13,14].

The primary aim of this study is to conduct an in-depth analysis of our experience as a reference center for HCC treatment, focusing on the oncological outcomes of TAE, including objective response, OS, and time to progression (TTP), in patients treated between 2016 and 2021. In addition, the study seeks to analyze demographic, clinical, imaging, and procedural variables to compare our findings with existing literature.

Materials and methods

Patient cohort and selection criteria

We conducted a retrospective review of patients treated with TAE for HCC at our institution between January 2016 and December 2021. Two interventional radiologists independently reviewed the digital medical records, extracting data on clinical characteristics, laboratory values, endovascular procedures, and post-TAE outcomes. Patients were eligible for inclusion if they met the following criteria: age ≥ 18 years; a diagnosis of HCC confirmed by either imaging or histopathology; available pre- and post-treatment multiphasic computed tomography (CT) or magnetic resonance imaging (MRI); classified as Child-Pugh (CP) class A or B and BCLC stages A or B; selected for TAE by a multidisciplinary tumor board; and had clinical and radiological

follow-up data ranging from at least 1 month to a maximum of 3 years post-treatment (up to July 31, 2023).

Exclusion criteria included: patients treated with TAE in conjunction with other locoregional therapies (e.g., radiofrequency ablation, microwave ablation, percutaneous alcohol injection, conventional TACE, or drug-eluting bead TACE); absence of suitable post-treatment imaging or follow-up data; incomplete clinical or procedural documentation; diffuse or infiltrative HCC; or patients deemed ineligible for locoregional TAE therapy.

Variables included demographic data (age and gender), comorbidities (obesity, hypertension, diabetes, autoimmune diseases, smoking, heart failure, and chronic kidney disease), presence and etiology of cirrhosis, CP and ALBI scores, pre- and post-TAE alpha-fetoprotein levels, BCLC and Okuda classification, Milan criteria compliance, and Eastern Cooperative Oncology Group (ECOG) status. Pre-TAE variables such as lesion size, number, and treatment objectives (downstaging, bridge therapy, therapeutic state migration, or definitive treatment) were also recorded. In addition, TAE device costs were calculated, covering angiography suite, access catheter, guides, introducer, endovascular catheters, microcatheter, microguide, embolizing agents, and vascular closure. Costs related to personnel, post-procedure care, hospitalization, medications, follow-up, and imaging were excluded from the study. Intra-procedural data collected included the arterial access route (radial or femoral), devices utilized, type of embolic agents administered, costs of materials, and total procedural costs. Post-TAE variables encompassed the size of the viable tumor area following treatment, objective response rate (ORR), response categorization per modified RECIST (mRECIST) criteria – namely, complete response (CR), partial response (PR), stable disease (SD), and progressive disease (PD) – with ORR defined as the sum of CR and PR. Additional outcomes assessed included OS at 1 and 3 years, PFS, disease-free survival (DFS), TTP, disease control rate (DCR), duration of hospitalization, incidence of post-TAE complications, and the occurrence of post-embolization syndrome. During follow-up, contrast-enhanced imaging studies were performed to evaluate tumor response at the end of the observation period according to mRECIST response categories. Time to best response was not assessed.

The study protocol was reviewed and approved by the Institutional Ethics Committee under approval number RAD 4623-23-23-1. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and national regulations issued by the Mexican Ministry of Health. Given that this was a retrospective study categorized as minimal risk, the requirement for informed consent was waived.

TAE technique

Eligibility for the procedure was determined through a comprehensive evaluation, including a review of pre-TAE multi-phase contrast-enhanced CT/MRI scans, laboratory results, bone scintigraphy, and plain chest CT. These findings guided the approach for lesion embolization. The procedure was scheduled accordingly.

After obtaining informed consent and explaining the procedure to the patient or their family, the femoral or radial approach was performed using a modified Seldinger technique, followed by the advancement of a 5 Fr introducer. Under fluoroscopic guidance, the celiac trunk was cannulated using a 5Fr angiographic catheter (Cobra C2, Simmons, MHK, SHK) and a 0.035" × 150 cm teflon-coated guide wire, followed by digital subtraction angiography. The coaxial microcatheter/microwire system, generally 0.021/0.016", was used to navigate from the common hepatic artery to the segmental artery where the lesion was located. Angiography was performed to characterize the lesion, typically showing nodular enhancement or a "tumor blush." The selectivity of the embolization territory was confirmed using cone-beam CT (CBCT).

Embolization was carried out under continuous fluoroscopic control, generally using PVA particles of 50-150 microns or "BeadBlock" microspheres of 100-300 microns mixed with contrast medium. The embolizing agent was divided into quarters or fifths, and the procedure continued until the lesion was "tattooed" and/or there was stasis of the tumor's blood flow. The embolized territory was re-confirmed using CBCT. After removing the catheter and microcatheter system, hemostasis was achieved with sustained compression for 15 min or using a vascular closure system. Typically, patients were hospitalized for < 48 h for monitoring and management of complications. A follow-up with multiphase contrast-enhanced CT/MRI and laboratory tests was performed at 1-month post-TAE to categorize the type of response according to mRECIST (CR, PR, EE, PE) and determine further follow-up or management based on imaging findings.

At the National Institute of Medical Sciences and Nutrition Salvador Zubiran, post-TAE follow-up is protocolized. Follow-ups with imaging and laboratory tests

are conducted monthly in cases of SD or PR. In cases of CR, the follow-up occurs every 3 months for 2 years; with a chest CT every 6 months. In cases of tumor recurrence, the case is re-evaluated in a multidisciplinary consensus for decision-making.

Statistical analysis

Categorical variables were reported as absolute counts and percentages. Quantitative variables with parametric distribution were summarized using means and standard deviations, whereas non-parametric variables were described using medians and interquartile ranges (IQR). Time-to-event variables were analyzed using median survival times and incidence rates. OS was evaluated using Kaplan-Meier analysis for both crude OS and stratified according to post-TAE radiological response categories. Survival curves and corresponding median times to event are presented graphically.

Response to TAE was classified using the modified Response Evaluation Criteria in Solid Tumors (mRECIST), which defines four categories: CR, PR, SD, and PD. From the date of the TAE procedure, the ORR was calculated as the sum of CR and PR. OS was defined as the time from TAE to death from any cause or the last documented follow-up. PFS was defined as the duration from TAE until disease progression, death, or loss to follow-up. DFS was assessed in patients who achieved a CR and was defined as the interval from post-TAE to recurrence, death, or last follow-up. TTP was defined as the period from TAE to the first radiological evidence of disease progression per mRECIST.

Data were independently extracted and verified by two interventional radiologists using the Carestream imaging platform and electronic health records. Statistical analyses, including Kaplan-Meier curve generation, were conducted by the principal author, co-author, and a collaborator with a Master's in Epidemiology. The statistical programming language R was used, employing the Survival and Survminer packages. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.

Results

Between January 2016 and January 2021, a total of 30 patients met the inclusion criteria and were enrolled in the study. The patient selection process is illustrated

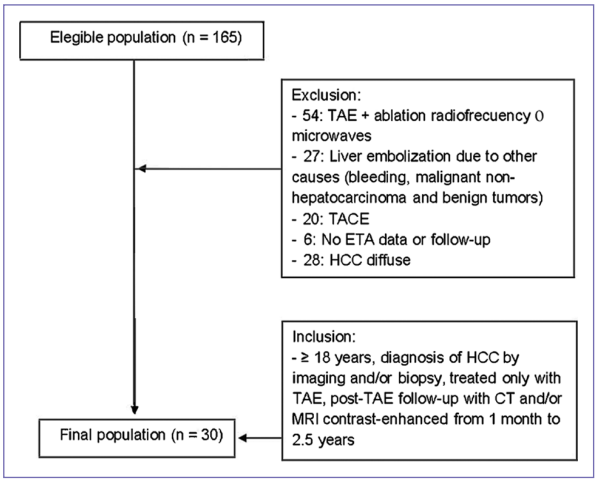

Figure 1. Flowchart shows the process for selecting hepatocellular carcinoma patients treated with transarterial embolization alone.

in figure. 1. The cohort included 16 women (53%), with a median age of 73 years (IQR: 64-79 years). The most common comorbidities were hypertension in 19 patients (63%), diabetes mellitus in 13 (43%), and obesity in 5 (16%). A total of 28 patients (93%) had underlying cirrhosis, with the principal etiologies being viral hepatitis in 11 cases (36%), cryptogenic in 10 (33%), alcohol-related liver disease in 4 (13%), and primary biliary cholangitis in 2 (6%).

Most patients were classified as CP B (23 cases, 76%). According to BCLC staging at the time of TAE, 21 patients (70%) were categorized as stage B and 9 (30%) as stage A. Only five patients fulfilled the Milan criteria. Based on the Okuda classification, 23 patients (76%) were classified as stage II or III, while 7 (24%) were classified as stage I. According to the Albumin-Bilirubin (ALBI) score, 18 patients (60%) were ALBI grade 2, and 8 (26%) were grade 3. Regarding functional status, ECOG performance scores were 0 in 7 patients (23%), 1 in 20 (66%), and 2 in 3 (10%). Lesions were predominantly classified as LI-RADS 5 (95%). The transverse tumor diameter ranged from 43 to 123 mm, with a mean of 41 mm, median of 37 mm, and a total of 46 measurable lesions (N = 46). The indications for TAE were as follows: definitive treatment in 18 patients (60%), downstaging in 8 (26%), and bridge therapy to liver transplantation in 4 (14%). Eight patients (26%) were enrolled in a liver transplantation protocol, of whom 4 (13%) ultimately underwent transplantation (1 classified as CP A, 3 as CP B). Among these transplant recipients, three achieved a CR and one a PR following TAE. Two patients received stereotactic body

Table 1. Demographic and clinical characteristics

	(n = 30)
Gender	
Women	16 (54%)
Age (years)	
Median	73 (IQR 64 a 79)
Quartile 1th	64
Quartile 3th	79
Comorbidities	
Diabetes	13 (43%)
Hypertension	19 (63%)
Obesity	5 (16%)
Osteoporosis	4 (13%)
Hypothyroidism	2 (6%)
Heart failure	1 (3%)
COPD	1 (3%)
Ulcerative colitis	1 (3%)
Cirrhosis (etiology)	28 (93%)
Alcoholic	3 (10%)
HCV	11 (13%)
HBV	1 (3%)
Cholangitis	3 (10%)
Cryptogenic	5 (16%)
Autoimmune hepatitis	1 (3%)
Primary biliary cirrhosis	1 (3%)
Not cirrhosis	2 (7%)
Pre TAE alpha-fetoprotein levels (ng/mL)	
Median RIC	16.5 (IQR 5 to 147)
First cuartil	5
Third cuartil	147
Post TAE alpha-fetoprotein levels (ng/mL)	
Median	6
First cuartil	4
Third cuartil	74
PreTAE alpha fetoprotein levels (ng/mL)	n = 30 (%)
> 400	6 (20%)
< 400	24 (80%)
Child Pugh PreTAE	n = 28 (%)
A	5 (18%)
B	23 (82%)
BCLC PreTAE	n (%)
A (early)	9 (30%)
B (intermediate)	21 (70%)
ALBI Score	
1	4 (13%)
2	18 (60%)
3	8 (26%)
ECOG	
0	7 (23%)
1	20 (66%)
2	3 (10%)
Milan criteria	
Yes	5 (16%)
No	7 (23%)
Okuda classification	
II	23 (76.6%)
III	7 (23.3%)

(Continues)

Table 1. Demographic and clinical characteristics *(continued)*

	(n = 30)
Target of TAE treatment	
Definitive treatment	18 (60%)
Downstaging	7 (26%)
Bridge therapy to liver transplantation	5 (14%)

*COPD: chronic obstructive pulmonary disease; IQR: interquartile range.

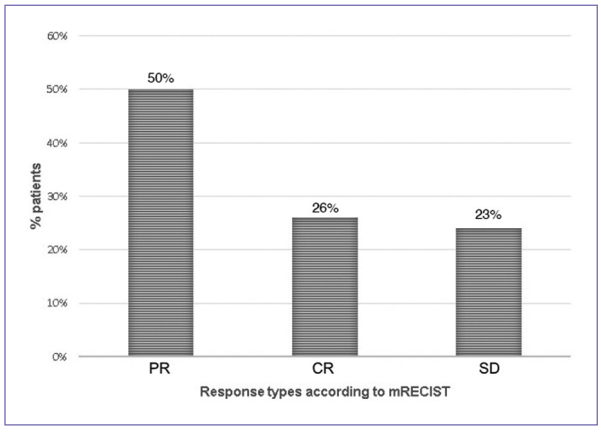

Figure 2. Percentage of patients and response types according (PD, PR, SD, and PR) to modified RECIST.

radiation therapy (SBRT) following embolization. Notably, 3 patients (10%) experienced long-term (> 6 months) hepatic function deterioration post-TAE (Table 1).

According to mRECIST criteria, the ORR was 76% at the end of the follow-up. CR was observed in 8 patients (26%), PR in 15 cases (50%), and SD in 7 patients (23%) (Fig. 2). The best radiological response, represented by CR cases, showed no differences in technique or patient characteristics with those with PR or SD (Fig. 2).

The median follow-up was 55.73 months (95% CI 55.03 to 69.97). The median OS was 26.28 months (95% CI 13.33 to not estimable). The OS rate was 66.7% at 12 months, 36.67% at 3 years (95% CI: 22.91 to 58.7%), and 23.3% at the end of follow-up (Fig. 3).

By response type, median survival was 28.3 months (95% CI: 6.9 to not estimable) for SD, 23.7 months (95% CI: 4.4 to not estimable) for CR, and 18.5 months (95% CI: 9.0 to not estimable) for PR (Fig. 4). The corresponding 3-year OS rates were 28.6% for SD, 50.0% for CR, and 33.0% for PR (Fig. 4).

The median survival time according to BCLC stage was 30.9 months (95% CI: 4.4 to not estimable) for patients with stage A and 24.1 months (95% CI: 13.1 to not estimable) for those with stage B. Stage survival

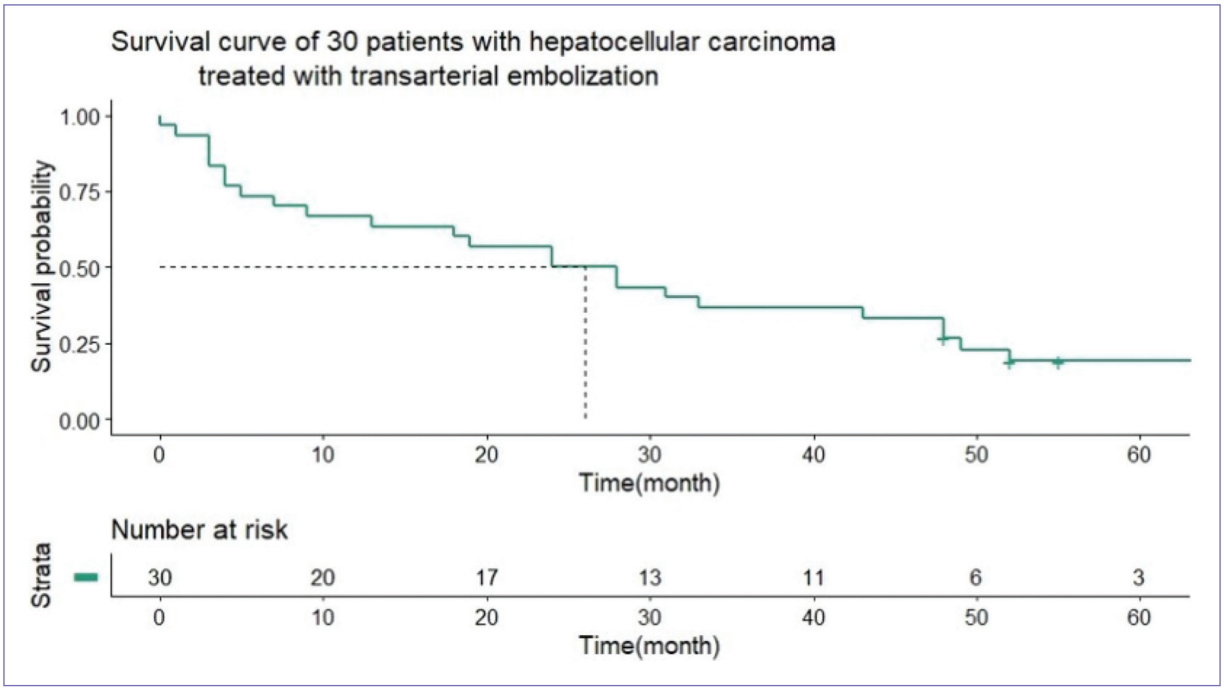

Figure 3. Kaplan-Meier curve of overall survival (OS) in the cohort. The dashed line indicates the median survival time of 26.28 months (95% confidence interval: 13.33 to not estimable). At 3 years, the OS rate was 36.7%. The shaded area represents the 95% confidence interval. The number of patients at risk is shown below the X-axis.

rate at 3 years was 20 and 30 % for stage A and B, respectively.

The upper limit of the confidence interval (CI) could not be estimated in group analyses due to an insufficient number of events.

A total of 41 TAE procedures were performed, targeting 54 lesions. The femoral approach was predominantly used, utilizing a 5 Fr Cobra catheter and hydrophilic guide wire for celiac trunk access. For superselective cannulation of the hepatic artery, the Direxion microcatheter was frequently employed, and polyvinyl alcohol (PVA) particles were the most common embolizing agent. Vascular closure was typically achieved through compression. Post-TAE imaging studies revealed that the average size of residual lesions was about 22 mm in the axial plane (Tables 2 and 3, Fig. 5).

A total of 7 adverse events (13%) were observed, classified according to the Common Terminology Criteria for Adverse Events v5.0 as follows: Grade 5 in one patient, Grade 3 in two cases, Grade 2 in three patients, and Grade 1 in one case. Four patients experienced post-embolization syndrome (Grade 2), and one developed duodenitis (Grade 2). Another patient, with a pre-TAE lesion larger than 10 cm, developed a hepatic abscess with secondary bacteremia caused by *Aeromonas* spp. and *Clostridioides difficile* (Grade 3). One patient

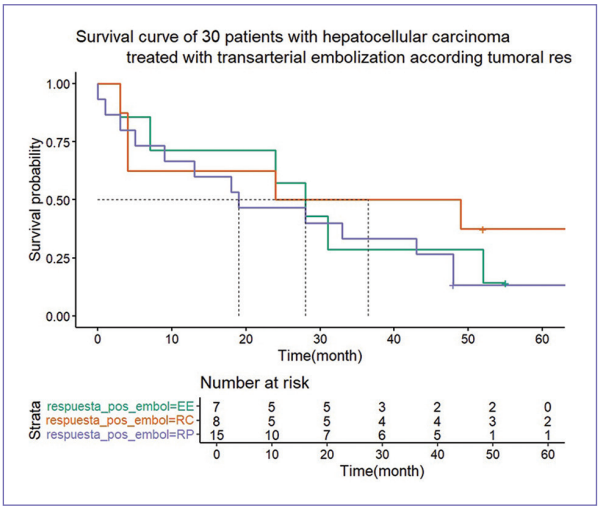

Figure 4. Kaplan-Meier curves of overall survival (OS) stratified by tumor response type. The dashed lines represent median survival times: 28.3 months (95% confidence interval: 6.9 to not estimable) for stable disease (SD, green), 23.7 months (95% confidence interval [CI]: 4.4 to not estimable) for complete response (CR, brown), and 18.5 months (95% CI: 9.0 to not estimable) for partial response (PR, violet). The corresponding 3-year OS rates were 28.6% for SD, 50.0% for CR, and 33.0% for PR. Shaded confidence intervals around the survival curves were not plotted due to their wide range.

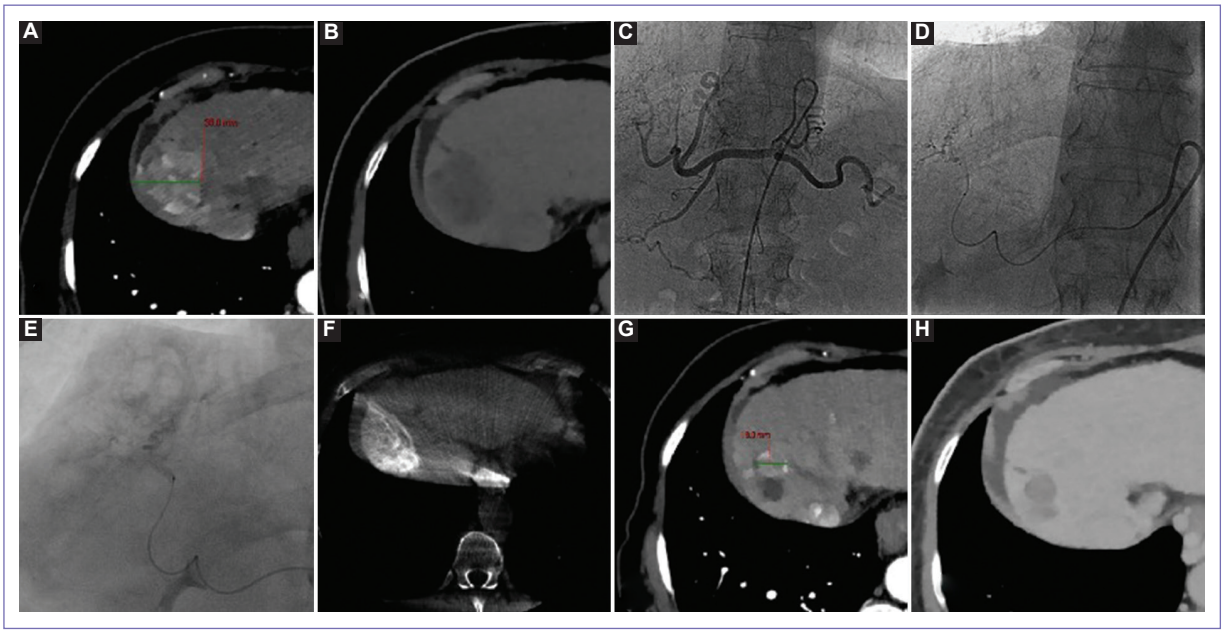

Figure 5. Case no. 5, transarterial embolization (TAE) and post TAE changes at the 1st month, with partial response (PR) according to mRECIST. **A** and **B:** contrast images in axial, arterial and venous phase, compatible with LIRADS 5 lesion in segment 7-8 with 39 mm diameter in axial. **C:** cannulation and selective angiography of the celiac trunk with a Simmons angiographic catheter. **D:** supraselective catheterization of the common, proper, and right hepatic arteries and segmental branches of the lesion in segment 7-8. **E:** nodular or "tumor Blush" enhancement of the lesion to be embolized (white arrow). **F:** axial CBCT corroborates the selectivity of the territory to be embolized (white arrow). **G** and **H:** postTAE changes in axial, arterial and venous phase, in relation to LIRADS-viable, PR, residual lesion measures 18 mm in axial, decreased 50%.

Table 2. Characteristics of the TAE procedure

Total embolized lesions	(n = 54)
TAE access	
Radial	2 (5%)
Femoral	39 (95%)
Lesion size (mm) preTAE	mm
Minimum	20
Maximum	123
Median	43
Viable zone size of post-TAE lesions (mm)	
Minimum	0
Maximum	59
Average	22
Median	20

TAE: transarterial embolization.

Table 3. Medical devices used in the TAE

Catheters	(n = 41)
Cobra 5Fr	31
SH (Shepherd Hook) 5Fr	1
Simmons 5Fr	8
Multipurpose 5Fr	1
Hydrophilic guide 0.035"	34
Teflon guide 0.035"	7
Microcatheter	
Progreat®	1
Direxion™	40
Embolizing agents	
PVA 50-150 micras	18
PVA 150-250 micras	20
Microspheres 100-300 micras	3
Vascular closure	
Compression	40
Vascular closure system	1

experienced acute liver failure (Grade 3), while one patient with pre-existing coronary artery disease died due to ventricular dysfunction complications (Grade 5).

According to the Society of Interventional Radiology (SIR) classification, two cases were categorized as major adverse events and four as minor[12] (Table 4). The median hospital stay after a TAE was 3.3 days. The costs of materials and resources used per TAE procedure – including angiography suite time, arterial introducer (femoral or radial), Teflon-coated or hydrophilic guidewire, angiographic catheter, microcatheter,

Table 4. Characteristics of adverse events

Description del AE-SIR*						Stay		Category	CTCAE V.5 Grade**
#	Nausea	Vomiting	Pain	Fever	Other findings	> 48 h	< 48 h		
1	Yes	No	Yes	Yes	No	No	-	Minor	2
2	Yes	Yes	Yes	Yes	duodenitis	No		Minor	2
3	No	No	Yes	Yes + infection	Abscess, bacteremia	-	Yes	Major	3
4	No	No	Yes	Yes	No	No		Minor	1
5	No	No	Yes	Yes	Acute liver failure		Yes	Major	3
6	No	No	Yes	Yes	No	No	-	Minor	2
7	No	No	No	No	Left ventricular systolic dysfunction	yes		Major	5

*Society of Interventional Radiology (SIR).
**Common Terminology Criteria for Adverse Events (CTCAE) version 5.0.

high-pressure syringe, and embolic agent (either PVA particles or microspheres), as well as vascular closure systems – ranged between $2,780 and $2,870 USD per procedure. By contrast, institutional calculations for the cost of a single transarterial chemoembolization (TACE) procedure amounted to approximately $5,500 USD.

Discussion

Randomized clinical trials have reported that OS and objective response are similar between TAE and TACE. However, biases exist that diminish the robustness of TACE results, making it difficult to conclude the role of chemotherapy in unresectable HCC. In a randomized controlled trial by Llovet et al., comparing TACE, TAE, and controls in a total of 112 patients with unresectable HCC, survival rates for TAE (gelfoam) at 1, 2, and 3 years were 75, 50, and 29% (median of 25.3 months), and for TACE (gelfoam with doxorubicin) were 82, 63, and 29% (median of 28.7 months)[14]. Lencioni et al., in a study involving over 10,000 patients undergoing TACE, reported 1-, 3-, and 5-year survival rates of 70.3, 40.4, and 32.4%, respectively, with a median OS of 19.4 months. More recently, Roth et al. compared TAE and TACE and reported a median OS for the entire cohort of 27.7 months, with survival rates of 76, 54, and 39% at 1, 2, and 3 years. They also compared the objective response by mRECIST for TAE and TACE, which were 67.4 and 54.6%, respectively. The median PFS was 9.3 months with no significant differences between TAE and TACE (9 months vs. 10.8 months, p = 0.5)[9].

In a randomized trial by Brown et al.,[4] TAE using either plain microspheres or those loaded with doxorubicin was compared, showing no significant differences in OS between both groups (21.4 and 20.8 months, (p = 0.64; hazard ratio [HR] = 1.31; 95% CI = 0.81-2.12), nor in PFS (6.2 and 2.8 months (p = 0.11; HR = 1.36; 95% CI = 0.91 to 2.05). The response rates according to RECIST 1.0, mRECIST, or EASL criteria, as well as adverse events, were also similar.

A national retrospective study conducted in Mexico by Enrique Miguel Cruz et al.[15] compared treatment responses and PFS in patients undergoing TACE versus TAE. The study found no statistically significant differences in treatment response (p = 1.0) or PFS (p = 0.1639). According to mRECIST criteria, treatment response in the TAE group was as follows: 33.3% achieved CR, 33.3% had SD, 11.1% had a PR, and 22.2% showed disease progression (PD). In the TACE group, 22.2% achieved CR, 22.2% SD, 33.3% PR, and 22.2% PD. Median PFS was 6.88 months for TAE and 10.55 months for TACE (p = 0.1639). While international guidelines currently recommend TACE as the standard locoregional endovascular therapy for unresectable HCC in BCLC stage B, access to this modality remains limited in many low- and middle-income regions. Barriers include the higher procedural cost, lack of adequately trained personnel, and insufficient infrastructure in specialized centers, making TAE a viable and cost-effective alternative for locoregional therapy in these settings[16].

In Latin America, systemic disparities in healthcare access further complicate the management of HCC. Public health systems are primarily responsible for financing care for patients from lower socioeconomic

strata, covering screening, diagnosis, and treatment. In contrast, individuals from higher-income groups generally access care through private insurance and providers. Surveillance programs for early detection and treatment of HCC are underutilized in developing countries, contributing to a low rate of early-stage diagnosis and timely intervention[15]. In these regions, TACE is often the first-line transarterial treatment for approximately 35% of HCC cases. However, there is considerable heterogeneity in TACE protocols, including variability in patient selection, chemotherapeutic agent types and dosages, infusion rates, and retreatment strategies[17].

In this context, TAE plays an important role in the management of unresectable HCC, with multidisciplinary groups and cost-effective treatment aimed at "down staging," bridging therapy, transitioning of therapeutic stage, or as final treatment.

The costs of materials and procedures associated with TAE have not been widely documented in the literature, either nationally or internationally. This may be attributed to TAE's non-standardized role in treatment guidelines and limited access to multidisciplinary teams and locoregional therapies in many settings.

In a study conducted in the United Kingdom by Waleed Fateen et al., the cost of conventional TACE was reported at approximately $3,300 USD, while TACE with drug-eluting beads was estimated at $4,000 USD[10]. Similarly, in Colombia, Bejarano Ramírez et al. reported the cost of TACE in their cost-effectiveness analysis of locoregional therapies for HCC, ranging between $2,512 and $6,851 USD[13].

In our study, we did not find differences in oncological outcomes (ORR, OS, DFS, and PFS), leading us to consider TAE as an optimal therapy for managing HCC. Moreover, we consider that these findings are important for future decisions regarding the treatment of locoregional therapies in unresectable HCC and can aid in budgeting and managing healthcare expenditures for high-cost oncological diseases in developing countries or regions with limited resources. Despite the evidence described between TACE and TAE, more randomized clinical trials are necessary to further establish their efficacy in oncological outcomes. Strengths of this study include the use of a multidisciplinary board for patient selection, consistent post-TAE imaging follow-up, and a homogeneous embolization technique. Limitations include its retrospective design, small sample size, lack of cost standardization, and the absence of direct comparison with other locoregional therapies.

Conclusion

TAE demonstrated an ORR and OS like those reported in the international literature, but at a lower cost.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethical considerations

Protection of humans and animals. The authors declare that no experiments involving humans or animals were conducted for this research.

Confidentiality, informed consent, and ethical approval. The authors have obtained approval from the Ethics Committee for the analysis of routinely obtained and anonymized clinical data, so informed consent was not necessary. Relevant guidelines were followed.

Declaration on the use of artificial intelligence. The authors declare that no generative artificial intelligence was used in the writing of this manuscript.

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