The Expanding Role of Balloon-Occluded TACE in Hepatocellular Carcinoma

Authors: Layth Khawaja[1], Saad Badat[1], Mina S. Markary

Institutions: [1]Northeast Ohio Medical University, [2]Ohio State University Wexner Medical Center

Northeast Ohio MEDICAL UNIVERSITY

Introduction

Hepatocellular carcinoma (HCC) is a leading cause of cancer-related mortality worldwide with increasing incidence in Western countries. Traditional treatments such as surgical resection and liver transplant are of limited use in more advanced stages of HCC.

Balloon-occluded transarterial chemoembolization (B-TACE) represents a promising evolution in intra-arterial therapy, utilizing temporary arterial flow occlusion using a microballoon catheter to allow for pressure-enhanced infusion of chemotherapy and lipiodol directly into the tumor, followed by embolization with particles.

Purpose:
This educational exhibit aims to provide a focused overview of B-TACE in the treatment of hepatocellular carcinoma, highlighting its advantages, limitations, and future directions in interventional oncology.

Methods

We assembled a case-based, illustrated review of B-TACE, covering micro-balloon selection, occlusion strategy, pressure-driven drug infusion and imaging follow-up. PubMed was searched (2008-2025) for original series, prospective trials and technical papers that reported safety, tumor response or pharmacokinetic data specific to B-TACE. Key findings were distilled into procedural pearls and unanswered research questions

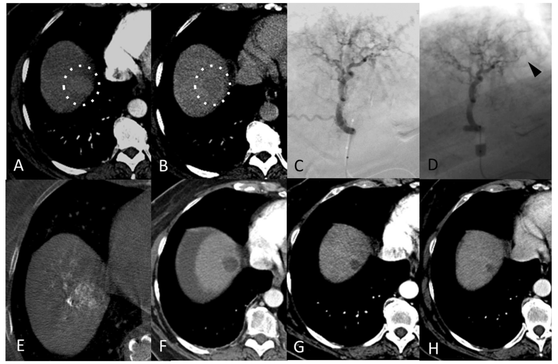

Fig. 1A A 64-year-old woman, with alcoholic and HCV cirrhosis complicated by a slightly hypervascular HCC in the arterial phase (A, dotted circle) in segment VIII, with late washout (25 mm) (B, dotted circle), undergoing a balloon-occluded TACE procedure. The angiography performed with a deflated balloon confirmed the poor hypervascularity of the nodule (C) which improved after balloon inflation (D, arrow head). The unenhanced cone beam CT performed at the end of the bTACE showed the good deposition of the particles within the nodule (E). One-month post-procedure CT arterial phase follow-up showed a complete response (F) sustained at 12 months (G) and at the last follow-up available, carried out at 24 months (H). **Adapted from Lucatelli et al.**

Results

- **Liu et al. Meta-Analysis (n=1,166):**
  - 5 studies comparing B-TACE vs conventional TACE
  - 262 B-TACE patients, 904 conventional TACE patients
  - Early to intermediate-stage HCC patients
  - 927 (79.5%) Child-Pugh A, 232 (19.9%) Child-Pugh B
- **Lucatelli et al. European Cohort (n=73):**
  - Single-arm retrospective study across 5 European centers
  - Mean age: 67.9 ± 12.1 years
  - Mean nodule diameter: 37 ± 19.9 mm
  - Mean number of nodules: 2.07 ± 1.68
  - 56 (76.7%) Child-Pugh A, 17 (23.3%) Child-Pugh B

Primary Efficacy Outcomes:

- **Complete Response Rates:**
  - **Liu et al.:** B-TACE vs conventional TACE
    - Risk ratio: 1.21 (95% CI 1.04-1.42, p=0.02)
    - B-TACE significantly improved CR rates
  - **Lucatelli et al.:** Single-arm B-TACE results
    - **6 months:** 58.9% complete response
    - **Last follow-up:** 49.3% complete response

Objective Response Rates:

- **Liu et al.:** B-TACE vs conventional TACE using RECICL criteria
  - Risk ratio: 1.23 (95% CI 1.09-1.38, p=0.0006)
  - B-TACE: 96.1% vs conventional TACE: 79.4%

Survival Outcomes (Lucatelli et al.):

- **Mean overall survival:** 50.0 months (95% CI 44.2-55.7)
- **Median local recurrence-free survival:** 31.0 months
- **Median progression-free survival:** 9.3 months
- **Median follow-up:** 31.0 months

Technical Advantages (Liu et al.):

- **Lipiodol consumption:** B-TACE used more lipiodol than conventional TACE
- **Enhanced embolization efficacy:** Better drug penetration and tumor coverage
- **Maintained safety profile:** No significant increase in serious adverse events

Safety Profile:

- **Liu et al. findings:**
  - Post-embolization syndrome: higher in B-TACE (52.8% vs 40.7%, p=0.04)
  - No significant difference in other adverse events
  - No increase in grade ≥3 complications
- **Lucatelli et al. findings:**
  - Low major complication rate maintained
  - 75.4% of patients required no additional treatment sessions

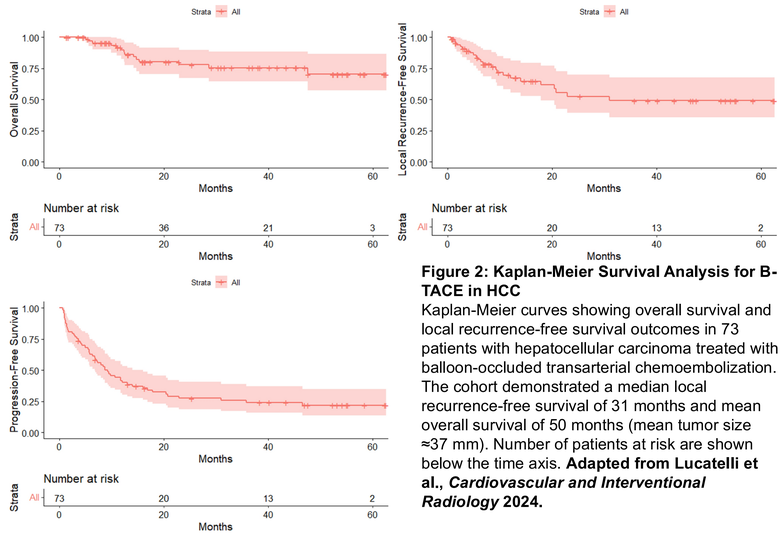

Figure 2: Kaplan-Meier Survival Analysis for B-TACE in HCC
Kaplan-Meier curves showing overall survival and local recurrence-free survival outcomes in 73 patients with hepatocellular carcinoma treated with balloon-occluded transarterial chemoembolization. The cohort demonstrated a median local recurrence-free survival of 31 months and mean overall survival of 50 months (mean tumor size ≈37 mm). Number of patients at risk are shown below the time axis. **Adapted from Lucatelli et al., *Cardiovascular and Interventional Radiology* 2024.**

Discussion

Improved efficacy: B-TACE shows higher complete and objective response rates compared with C-TACE
Favorable safety: Adverse events are mainly transient liver enzyme elevations; major complications remain low (<7%)
Refractory disease: Effective in patients with HCC not responding to C-TACE, offering a salvage option
Durable outcomes: Studies report longer local recurrence-free and overall survival with B-TACE
Future directions: Standardization of protocols and prospective trials are needed to confirm long-term survival benefits

Table 1 The comparation of adverse events (Any grade)

Study or subgroup subtotal (95% CI)	B-TACE (%)	cTACE (%)	Weight (%)	Risk ratio M–H, fixed, 95% CI	P
Clinical events					
Post-embolization syndrome	52.8	40.7	31.2	1.30 [1.01,1.68]	0.04
Fever	34.7	31.7	37.5	1.09 [0.85,1.39]	0.48
Nausea or vomiting	18.4	9.0	10.6	2.05 [1.20,3.50]	0.009
Abdominal pain	23.7	16.9	20.0	1.39 [0.93,2.08]	0.10
Liver abscess	3.5	0	0.6	6.00 [0.73,49.12]	0.09
Biological events					
Elevation of ALT	51.6	49.2	71.0	1.04 [0.95,1.14]	0.34
Elevation of total-bilirubin	42.4	38.8	29.0	1.09 [0.78,1.52]	0.61

B-TACE Balloon-occluded TACE, *cTACE* Conventional TACE, *CI* Confidence interval

Comparison of adverse events between B-TACE and C-TACE shows slightly higher rates of post-embolization syndrome and nausea/vomiting with B-TACE, while severe complications remained rare and overall safety was comparable. **(Lie et al.)**

References

- Lucatelli, P., Rocco, B., De Beare, T., Verset, G., Fucilli, F., Damato, E., Paccapelo, A., Braccischi, L., Taninokuchi Tomassoni, M., Bucalau, A. M., Catalano, C., & Mosconi, C. (2024). Long-Term Outcomes of Balloon TACE for HCC: An European Multicentre Single-Arm Retrospective Study. *Cardiovascular and interventional radiology, 47*(8), 1074–1082.
- Liu, J., Wang, W., Zhai, H., Ma, Y., You, Q., & Shao, H. (2025). Balloon-occluded versus conventional transarterial chemoembolization for the treatment of early to intermediate stage hepatocellular carcinoma: a meta-analysis and trial sequential analysis. *BMC cancer, 25*(1), 1036.
- Kim, P. H., Gwon, D. I., Kim, J. W., Chu, H. H., & Kim, J. H. (2020). The safety and efficacy of balloon-occluded transcatheter arterial chemoembolization for hepatocellular carcinoma refractory to conventional transcatheter arterial chemoembolization. *European radiology, 30*(10), 5650–5662