

# Balloon-Occlusion TACE for Treatment of HCC Complicated by Arterio-Portal and Arterio-Hepatic Venous Shunts

Maria del Pilar Bayona Molano<sup>1\*</sup>, Adam Swersky<sup>2</sup>, Bradley Fox<sup>2</sup>, Jay Vasani<sup>2</sup>, Jason Salsamendi<sup>2</sup> and Shivank Bhatia<sup>2</sup>

<sup>1</sup>Department of Interventional Radiology, Washington University of St Louis, 510 South Kings Highway Blvd St Louis, MO 63110, USA

<sup>2</sup>Department of Interventional Radiology, University of Miami Miller School of Medicine, Professional Arts Center Suite 702, 1150 NW 14th St, Miami, FL 33136, USA

## Abstract

Trans-arterial chemoembolization is a well-supported treatment option for patients with hepatocellular carcinoma who are not surgical or transplant candidates. The efficacy relies on the ability to catheterize the arteries directly feeding a tumor and inject chemo-embolic particles directly into the tumor under fluoroscopic guidance. In the presence of a vascular anomaly such as an arterio-portal or arteriohepatic shunt, the flow dynamics within the tumor are altered and may compromise conventional or drug-eluting bead trans-arterial chemoembolization. We present the case of a patient with hepatocellular carcinoma complicated by arterio-portal and arterio-hepatic vein shunts who was treated with a modified trans-arterial chemoembolization utilizing balloon-occlusion.

**Keywords:** Hepatocellular carcinoma • Trans-arterial chemoembolization • Balloon-occlusion • Arterio-portal shunt • Arterio-hepatic shunt • Hepatic vascular malformations

## Introduction

Hepatocellular carcinoma (HCC) is the most common primary liver malignancy, with a global incidence of 800,000 in 2012 [1]. The simultaneous occurrence of arterio-portal shunt (APS) in HCC has been reported as high as 28.8%-63.2% [2]. If present, any vascular shunt near an HCC nodule creates a dilemma in conventional TACE planning in that it favours flow away from the tumor and provides another conduit for non-target embolization. Huang et al, showed that among 596 patients with HCC, 27% of them had severe APS [3]. Okuda et al. reported that APS could occur through a tumor thrombus in the portal branch, in a retrograde direction via a peripheral tumor nodule, through a small tumor invading or amputating an artery, or through a tumor located near a major portal vein branch and supplied by a large artery [4]. Post ablative arteriovenous shunts have been described, particularly when using RFA, and ultimately impacting the overall prognosis [5]. The two major types of shunts are classified according to their venous outflow: arteriohepatic venous shunts and arterioportal venous shunts. They can be simple including one feeding artery draining into a vein corresponding to a fistula, or complex with multiple feeders draining into multiple systemic veins. In reality, patients with HCC who have severe APS can be excluded from trans-arterial chemoembolization, especially using methiodal, because the flow of embolization material to normal liver tissue through the shunt can result in poor deposition of the compound in the tumor and ischemia of normal liver tissue.

Therefore, the occlusion of the shunt is important prior to embolization of the tumor. Multiple embolic agents such as gelatine sponge, ethanol, PVA particles, and coils have been used for the embolization of AP shunts but have had failures due to recanalization or difficulty accessing the shunt feeder vessel distally [6].

In 2013, Irie et al. described balloon-occlusion TACE (B-TACE), in which a micro-balloon catheter deployed proximal to the terminal arteries in the tumor results in decreased intra-tumoral vascular resistance and a negative pressure gradient causing flow diversion of therapeutic emulsion into the tumor [7]. This gradient not only results in an increased therapeutic effect, but also reduces the risk of non-target embolization due to flow reversal in nearby collaterals. Ward T. et al reported in patients undergoing hepatic radioembolization, a hepatopulmonary shunt reduction of 80%-90% including temporary balloon occlusion techniques [8]. Iezzi et al. described balloon-assisted RFA as a simultaneous percutaneous RFA ablation of the tumor with trans-arterial balloon occlusion of the feeder artery and subsequent intra-arterial TACE [9].

We present a case of a 57-year-old man with HCC complicated by a large flow arterio-portal and also arterio-hepatic shunts who successfully underwent B-TACE.

\*Corresponding author: Dr Maria del Pilar Bayona Molano, Department of Interventional Radiology, Washington University of St Louis, 510 South Kings Highway Blvd St Louis, MO 63110, USA, Tel: 314-230-6148; E-mail: bayonamolano@wustl.edu

**Copyright:** © 2020 Molano MPB, et al. This is an open-access article distributed under the terms of the creative commons attribution license which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

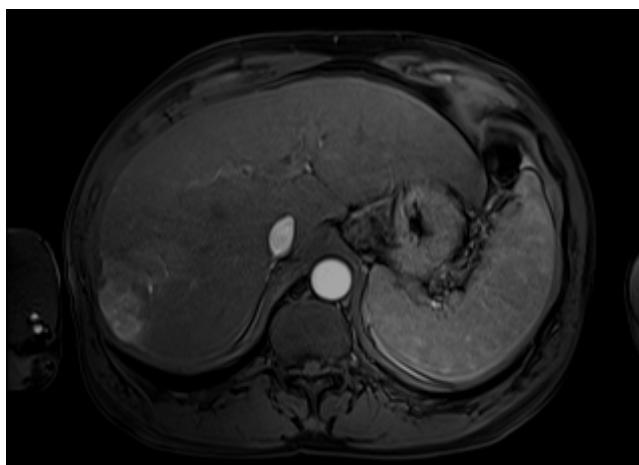
**Received:** February 28, 2020; **Accepted:** March 13, 2020; **Published:** March 20, 2020

## Case Report

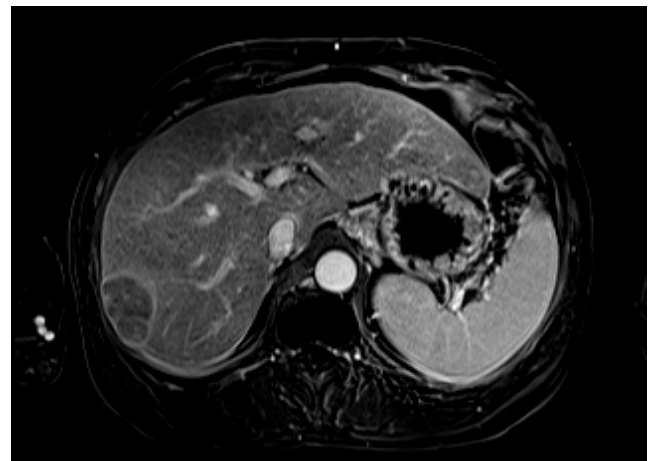
A 57 year-old-male with history of Hepatitis C (HCV) cirrhosis and a 4.1cm segment 7 HCC (Child-Pugh A, MELD-Na 16, ECOG 0) was referred to IR for TACE. His only symptom was occasional fatigue. Informed consent was obtained per institutional protocol.

Arterial access was gained via the right common femoral artery and a 6-French vascular sheath placed. The celiac artery was selected with a 5-Fr. cobra catheter and injected with contrast demonstrating the expected tumor blush in segment 7 from a segmental branch of the right hepatic artery. During this injection, a fast flow APS as well as an arterio-hepatic shunt were identified in the distal tumor bed as evidenced by an approximately 3.8 mm feeding tortuous artery and opacification of the portal and hepatic veins. A 2.8-Fr. Procreate microcatheter (Terumo, Somerset, NJ) and microwire combination were advanced into the segmental branch and super selective angiography confirmed a single arterial supply to the tumor, arterio-portal shunting, and significant shunting to the right hepatic vein. To ensure flow diversion into the tumor, we chose to utilize the balloon-occlusion technique for embolization. The microcatheter was exchanged over a microwire for a 2.2-Fr. Sniper balloon-occlusion microcatheter (Embolx, Sunnyvale, CA), which was inflated. Multiple pre-embolization angiograms were acquired to assess the behavior of the APS and right hepatic vein shunting, both with and without the balloon inflated. Evidence of flow stasis in the direction of the fistula and the right hepatic vein with the balloon inflated proved the safety of the balloon-assisted technique. DEB-TACE was then performed under fluoroscopic guidance through the microcatheter with the balloon inflated. The embolic mixture contained 150mg of 100-300µm beads loaded with doxorubicin.

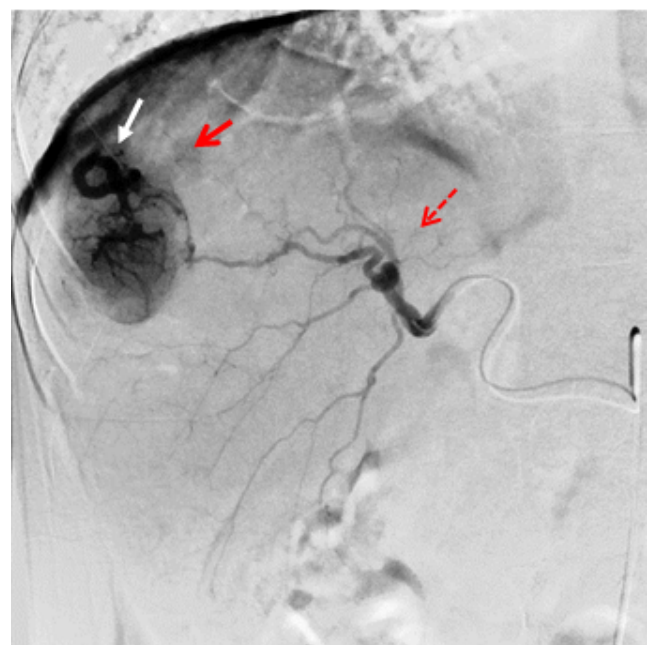
A completion angiogram demonstrated patency of the vessel with decreased flow and no evidence of arterio-portal or arteriovenous fistulae. Near-stasis was observed within the right hepatic artery segmental branch. He tolerated the procedure well and was admitted overnight for observation, then discharged the next day. On the fifth post-procedural day, he reported his pain was well-controlled with acetaminophen and denied any other symptoms. A follow-up MRI at 3 months demonstrated complete tumoral response without evidence of any residual suspicious enhancement (Figure 1-4).



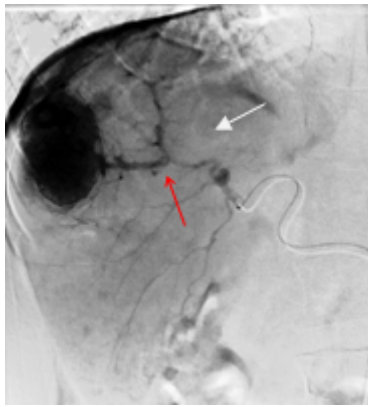
**Figure 1(A):** MRI liver with contrast sequences demonstrating a 4.2 cm mass with arterial hyperenhancement.



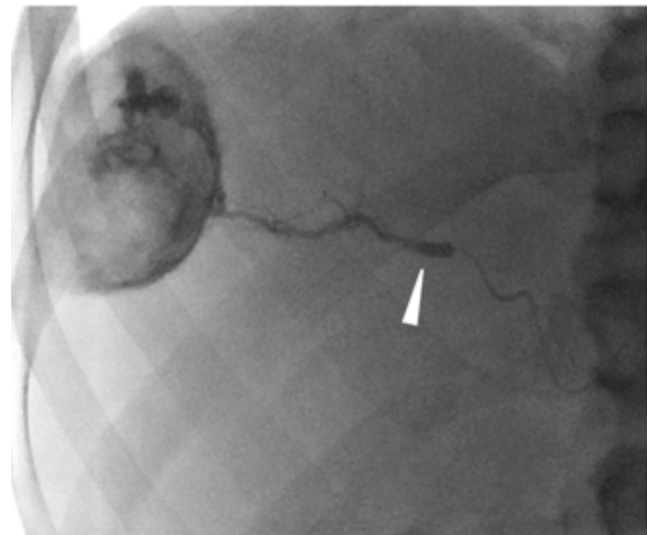
**Figure 1(B):** Delayed phase demonstrating washout and a pseudocapsule within segment 7 compatible with hepatocellular carcinoma (LI-RADS 5). The arterio-portal fistula was not clearly identified in any of the sequences.



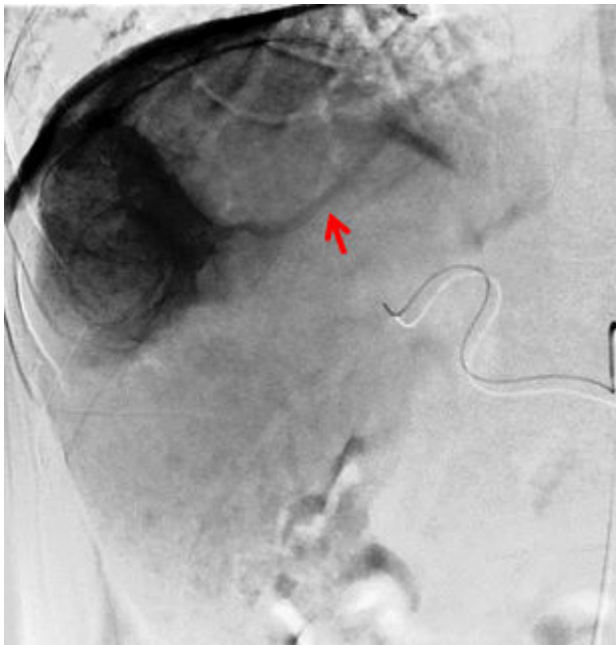
**Figure 2(A):** Subselective DSA of the right hepatic artery demonstrates the prominently tortuous branch supplying the tumor (white arrow), as well as a large draining vein (solid red arrow). The image also demonstrates early enhancement of the right portal vein (dashed red arrow). These findings are indicative of arterio-portal shunting within the tumor.



**Figure 2(B):** Subselective DSA of the right hepatic artery demonstrates the hyperenhancing mass in segment 7/8 of the right liver lobe, the branch of the right hepatic artery supplying the tumor (red arrow), and opacification of multiple right posterior portal vein branches (white arrow).



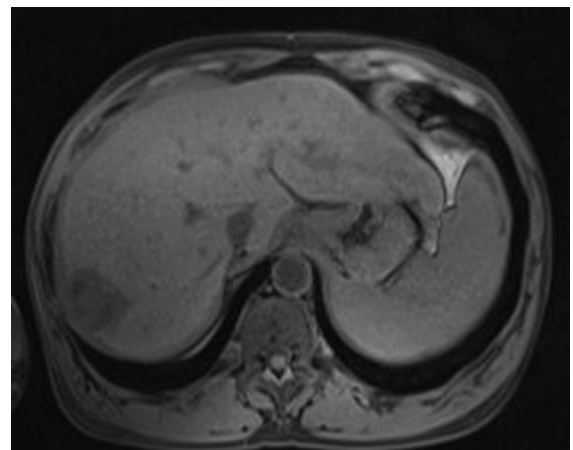
**Figure 2(D):** Subselective DSA of the right hepatic artery branch supplying the tumor with the inflated (white arrow) balloon occlusion catheter (Sniper Balloon Microcatheter, Embolx, Sunnyvale CA) shows enhancement of the tumor mass without opacification of any vessels that would suggest arterio-portal or arterio-venous shunting.



**Figure 2(C):** Delayed Subselective DSA of the tumoral branch of the right hepatic artery demonstrates arteriovenous shunting to the right hepatic vein (red arrow).

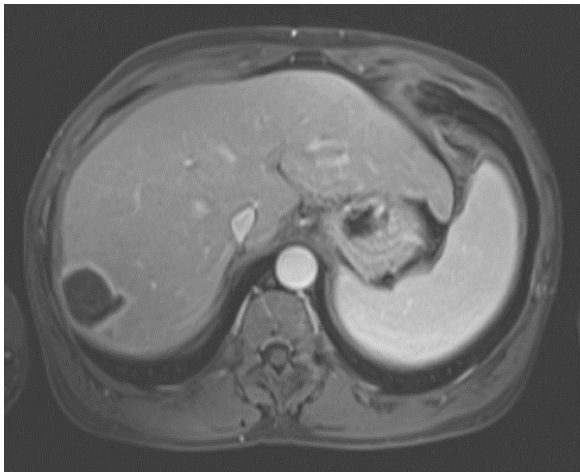


**Figure 2(E):** A post-embolization angiogram demonstrates complete occlusion of the vessels feeding the tumor and no further visualization of the arterio-portal fistula or hepatic venous shunt.

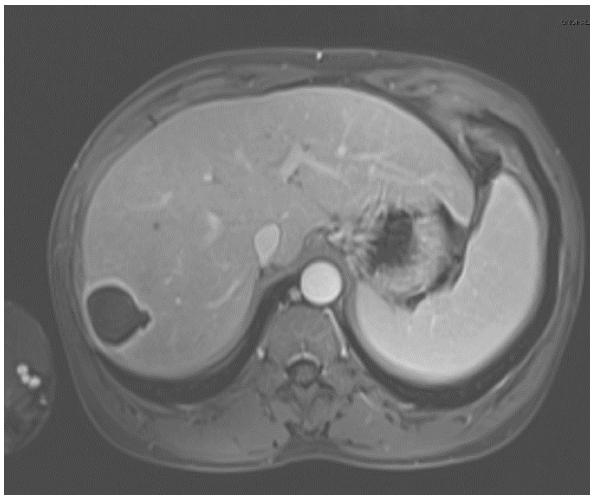


**Figure 3:** T1 pre-contrast MRI shows a hypointense lesion within segment 7, stable in size from prior imaging.





**Figure 4(A):** T1 post-contrast (arterial phase) shows no evidence of residual disease or recurrence of disease.



**Figure 4(B):** T1 post-contrast (delayed phase) shows no evidence of residual disease or recurrence of disease.

## Discussion

As the global incidence of HCC continues to accelerate, so too does the importance for refining and improving upon the established minimallyinvasive treatment options used to combat it. We demonstrate the utility of B-TACE in a scenario wherein arterio-portal and arterio-hepatic shunts presented an increased risk of non-target embolization, as well as threatened the opportunity for efficacious treatment. In the context of an arterio to venous shunt, the embolization planning will require evaluation of the shunt size, number of feeders, and knowledge of the behavior of each embolic agent to minimize any risk of non-desired migration of the embolic agent. Proximal embolization of a shunt can occlude the tumor-supplying artery, precluding the ability to perform TACE. A distal embolization into the shunt can cause portal vein thrombosis. The two situations can have potential devastating results including liver failure. An elegant solution involves the use of balloon-occlusion at the level of the artery feeding the tumor prior to infusion of the chemo-embolic emulsion, known as balloon-occlusion TACE. Occlusion of the feeding vessel alters the local pressure environment such that more flow is directed toward the tumor than would be with only the directionallytargeted injection employed by conventional

TACE (C-TACE). With the balloon inflated, this significant decrease in intra-tumoral vascular resistance not only reduces the likelihood of non-target embolization through existing arterio-venous shunt but also improves the concentrating effect of the emulsion responsible for TACE efficacy.

Alternative therapies in this situation have been described including the use of external radiotherapy for shunt obliteration after gelfoam embolization. The total response rate, including partial and complete obliteration, was 25% with a potential response delayed approximately 2 to 3 months for complete shunt obliteration after radiotherapy [10].

Hatanaka et al. hypothesized that the balloon assisted embolization decreased the arterial to portal vein gradient and therefore it increased the portal vein flow around the tumor [11].

Multiple studies have concluded that B-TACE significantly improves nodule control as compared to C-TACE as measured by increased treatment effect [12,13]. Characterization of the hemodynamic changes resulting from B-TACE support the clinical effects: one study demonstrated that the mean blood pressure in the occluded artery decreases significantly following balloon deployment [14]. Lucatelli et al. measured a significant decrease in the balloon-occluded arterial stump pressure (BOASP) before and after occlusion in addition to a clinical analysis that revealed significant decrease in tumor volume from treatment with B-TACE [15,16].

## Conclusion

The efficacy and safety of TACE both rely on the driving pressure towards the tumor and away from unintended collaterals-each of which can be optimized through utilizing the balloon-occlusion TACE method. These considerations are especially relevant in the context of any vascular anomalies that otherwise increase the likelihood of non-target embolization and under-treatment, such as APS. We therefore suggest the use of B-TACE in the case of any patient with undesired vascular shunting who is otherwise a TACE candidate.

### Compliance with Ethical Standards

This study was not supported by any funding. The authors declare that they have no conflict of interest. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study. This study has obtained IRB approval. Consent for publication was obtained for every individual person's data included in the study.

## References

1. Ghouri, YA, Mian I and Rowe JH. "Review of hepatocellular carcinoma: Epidemiology, etiology, and carcinogenesis." *J Carcinog* (2017), 16:1.
2. Ngan, H and Peh WC. "Arteriovenous shunting in hepatocellular carcinoma: Its prevalence and clinical significance." *Clin Radiol* (1997), 52:36-40.
3. Huang, MS, Lin Q, Jiang ZB and Zhu KS, et al. "Comparison of long-term effects between intra-arterially delivered ethanol and Gelfoam for the treatment of severe arterioportal shunt in patients with hepatocellular carcinoma." *World J Gastroenterol* (2004), 10:825-829.

4. Okuda, K, Musha H, Yamasaki T andJinnouchi S et al. "Angiographic demonstration of intrahepatic arterio-portal anastomoses in hepatocellular carcinoma." *Radiology*(1977),122:53-58.
5. Kondo, Y, Shiina S, Tateishi R andArano T, et al. "Intrahepatic bile duct dilatation after percutaneous radiofrequency ablation for hepatocellular carcinoma: impact on patient's prognosis." *Liver Int.* (2011), 31: 197-205.
6. Zhou, W, Shi H, Liu S and Yang ZQ,et al. "Arteriportal Shunts in Patients with Hepatocellular Carcinoma Treated Using Ethanol-Soaked Gelatin Sponge: Therapeutic Effects and Prognostic Factors." *J VascIntervRadiol*(2015), 26:223-230.
7. Irie, T, Kuramochi M and Takahashi N. "Dense accumulation of lipiodol emulsion in hepatocellular carcinoma nodule during selective balloon-occluded transarterial chemoembolization: Measurement of balloon-occluded arterial stump pressure." *CardiovascIntervRadiol*(2013), 36: 706-713.
8. Ward, T, Tamrazi A, Lam M and Louie JD,et al. "Management of High Hepatopulmonary Shunting in Patients Undergoing Hepatic Radioembolization." *J VascIntervRadiol* (2015),26: 1751-1760.
9. Iezzi, R, Ceasario V,Campanale M andPecere S,et al. "Su1222 New Therapeutic Perspectives for Management of Advanced Hepatocellular Carcinoma with Hepatic Arteriovenous Fistula: Balloon-Occluded Percutaneous Radio-Frequency Thermal Ablation (RFA) Plus Transcatheter Arterial Chemoembolization (TACE)." *Gastroenterology* (2012), 142: S-454.
10. Hsu, HC, Chen TY, Chiu KW and Huang EY, et al. "Three-dimensional conformal radiotherapy for the treatment of arteriovenous shunting in patients with hepatocellular carcinoma." *Br J Radiol*(2007), 80:38-42.
11. Hatanaka, T, Arai H andKakizaki S. "Balloon-occluded transcatheter arterial chemoembolization for hepatocellular carcinoma." *World J Hepatol*(2018), 10: 485-495.
12. Arai, H, Abe T, Takayama H andToyoda M,et al. "Safety and efficacy of balloon-occluded transcatheter arterial chemoembolization using miriplatin for hepatocellular carcinoma." *Hepatol Res* (2015),45: 663-666.
13. Ogawa, M, Takayasu K, Hirayama M andMiuraT, et al. "Efficacy of a microballoon catheter in transarterial chemoembolization of hepatocellular carcinoma using miriplatin, a lipophilic anticancer drug: Short-term results." *Hepatol Res* (2016),46: E60-E69.
14. Kakuta, A, Shibutani K, Ono S and Miura H, et al. "Temporal variations in stump pressure and assessment of images obtained from cone-beam computed tomography during balloon-occluded transarterial chemoembolization." *Hepatol Res* (2016),46: 468-476.
15. Lucatelli, P, CorradiniLG, De Rubeis G and Rocco B, et al. "Balloon-Occluded Transcatheter Arterial Chemoembolization (b-TACE) for Hepatocellular Carcinoma Performed with Polyethylene-Glycol Epirubicin-Loaded Drug-Eluting Embolics: Safety and Preliminary Results." *CardiovascIntervRadiol* (2019),42: 853-862.
16. Facciorusso, A, Di Maso M andMuscatielloN. "Microwave ablation versus radiofrequency ablation for the treatment of hepatocellular carcinoma: A systematic review and meta-analysis." *International journal of hyperthermia: The official Journal of European Society for Hyperthermic Oncology, North American Hyperthermia Group* (2016), 32: 339-344.

**How to cite this article:** Maria del Pilar Bayona Molano, Adam Swersky, Bradley Fox, Jay Vasani, Jason Salsamendi and Shivank Bhatia. "Balloon-Occlusion TACE for Treatment of HCC Complicated by Arterio-Portal and Arterio-Hepatic Venous Shunts". *J Oncol Transl Res* 6 (2020) doi: 10.4172/2476-2261.1000136