Case Report

Ablative radioembolization of hepatocellular carcinoma with total arterial supply originating from the superior adrenal artery achieved complete pathologic necrosis

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A R T I C L E   I N F O

Article history:
Received 21 September 2022
Revised 3 October 2022
Accepted 8 October 2022

Keywords:
Hepatocellular carcinoma
Extrahepatic vascular supply
Adrenal artery
Radiation segmentectomy
Ablative radioembolization

A B S T R A C T

Exclusively extrahepatic arterial perfusion to previously untreated, early-stage, hepatocellular carcinoma (HCC) is uncommon. We present a case of right superior adrenal artery completely supplying a subcapsular HCC in a 68-year-old male. The extrahepatic arterial territory targeted excluded structures potentially vulnerable to radiation, which allowed safe ablative Y-90 radioembolization that achieved complete pathological necrosis.

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Introduction

Transarterial radioembolization for hepatocellular carcinoma (HCC) relies on the quality of vascular supply for safety and efficacy. Development of extrahepatic supply to tumor can be influenced by numerous factors including tumor biology, an angiogenic microenvironment, location, size, and tumor ischemia. Ischemia is most often related to previous embolotherapy, most commonly chemoembolization [1]. Y90 radioembolization of extrahepatic arteries is an emerging technique that has shown early feasibility [2,3]. The case presented herein is a rare instance of a previously untreated early-stage HCC that lacked hepatic artery supply and had total extrahepatic arterial supply from the right adrenal artery. Superselective ablative radioembolization was safely performed via the adrenal artery as a bridge to liver transplan-
Fig. 1 – Baseline arterial phase enhanced T1W axial image of the liver (A) shows a subcapsular enhancing hepatocellular cancer. Venous phase of the same MRI sequence (B) showed contrast washout from the tumor and an enhancing pseudocapsule (arrowheads).

Fig. 2 – Axial cone-beam CT obtained while performing selective right hepatic arteriogram shows lack of enhancement that corresponds exactly to the tumor shown in Fig. 1. Review of all arteriography obtained from the hepatic arteries failed to show any tumor enhancement.

HCC was targeted for therapy with ablative radioembolization. Selective hepatic arteriography and contrast-enhanced cone-beam CT demonstrated that the HCC did not receive arterial perfusion from the hepatic arteries (Fig. 2). Right superior adrenal arteriography and cone-beam CT demonstrated hyperenhancement of the entire tumor exclusively from this vessel (Fig. 3). Ablative radioembolization with superselective administration of Y-90 glass microspheres into the right superior adrenal artery was performed with a single administration of estimated 1.2 million microspheres and specific activity of 1200 Bq/sphere that yielded an absorbed dose of 2037 Gy per single compartment Medical Internal Radiation Dose Methodology. The administered activity was highly conformal by Bremsstrahlung single-photon emission CT (Fig. 4) and resulted in a complete response by modified response evaluation criteria in solid tumors (Fig. 5). Histologic examination of the liver explant 12 months after radioembolization showed complete pathologic necrosis.

Discussion

The authors have previously published on ablative radioembolization via the adrenal artery, that partially contributed blood supply to a larger tumor, and histopathologic outcomes were not available [3]. The HCC described in this report originated in subcapsular hepatocytes, and remarkably, developed its angiographically detectable blood supply only from the right superior adrenal artery.

Most HCC have elevated expression of vascular endothelial growth factor, fibroblast growth factor, and platelet-derived growth factor, which promotes tumoral angiogenesis [4]. Arterial occlusion, especially after chemoembolization, stimulates commonly observed extrahepatic collateralization via 2 different mechanisms. One is a purely hemodynamic effect by creating a pressure gradient, increasing the transcapsular arterial flow to re-perfuse the hepatic lobules peripheral to the location of the hepatic arterial occlusion. The second

Case report

A 68-year-old diabetic male presented with non-alcoholic fatty liver disease-related cirrhosis, portal hypertension, esophageal varices, and ascites. An abdominal MRI revealed a 2.5 cm subcapsular HCC in segment VII of the liver with arterial hyperenhancement, delayed contrast washout, and pseudocapsule (Fig. 1). As a bridge to liver transplantation, the
Fig. 3 – Right inferior phrenic arteriogram (A) shows intense enhancement in the expected location of the tumor (arrowheads). The selective right superior adrenal arteriogram and the corresponding cone-beam CT (B and C) confirmed that it was the sole provider of arterial flow to the tumor.

Fig. 4 – Image fusion of Bremsstrahlung single-photon emission CT information and baseline T1W axial image of the liver after intravenous administration of intravenous contrast. The radioactivity is distributed sharply in the hepatocellular cancer and a rim of surrounding liver. The brachytherapy with Y90 microspheres was extremely conformal and only reached the intended target tissues.

Fig. 5 – Axial T1W image of the liver during venous phase of intravenous contrast distribution obtained 12 months after radioembolization. The treated volume of liver (arrowheads) and surrounding liver lack any abnormal enhancement to indicate a local recurrence or residual disease. This appearance on MRI correlates with complete pathologic necrosis.
mechanism is through the stimulation of angiogenesis, most prominently when tumor necrosis is incomplete. Sublethal ischemia of HCC has been associated with negatively altering tumor biology and correlates with HCC recurrence after liver transplant [5,6].

The liver capsule is mainly irrigated by extrahepatic inferior phrenic, omental, internal mammary, intercostal, and adrenal arteries, among others, that form a complex network that connects with and perfuses the peripheral sinusoids of subcapsular lobules [7,8]. It can be postulated that in the case presented the earliest tumoral cells were part of the subcapsular sinusoids dependent on the extrahepatic capsular arteries.

This patient’s HCC could have been successfully treated with thermal ablation, although tumor seeding with percutaneous ablation is rare, transarterial therapies avoid this complication. The small capacitance of the targeted adrenal artery may have limited the ability to deliver sufficient chemoembolization agent and altered flow to allow the hepatic arterial circulation to perfuse the periphery of the tumor, possibly resulting in partial necrosis. A single session of outpatient ablative radioembolization was successful in treating this lesion, made possible by its favorable blood supply from the right superior adrenal artery that did not perfuse critical non-target tissues. Furthermore, the confined anatomic compartment treated allowed safe delivery of a very high radiation dose without any short- or long-term untoward effects.

**Patient consent**

The patient granted informed consent for use of de-identified information and images.

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