

Evaluation of the Effect of Operator Experience on Outcome of Hepatic Artery Embolization of Hepatocellular Carcinoma in a Tertiary Cancer Center

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Abbreviations

TAE	Transarterial hepatic embolization
TACE	Transarterial chemoembolization
HCC	Hepatocellular carcinoma
OS	Overall survival
TLP	Time to local tumor progression
YOE	Years of operator's experience
IR	Interventional radiology
RFA	Radiofrequency ablation
BCLC	Barcelona Clinic Liver Cancer
ECOG	Eastern Cooperative Oncology Group
IRMD	Interventional radiology attending
5-FU	5-Fluorouracil

Rationale and Objectives: There is lack of information on the learning curve and the effect of operator's experience on the quality outcomes of transarterial hepatic embolization (TAE). The aim of this study was to evaluate the effect of operator experience on outcomes of TAE of hepatocellular carcinoma.

Materials and Methods: Demographic characteristics and outcomes including overall survival (OS), time to local tumor progression (TLP), and post-procedure complications in patients with hepatocellular carcinoma treated with TAE were collected. Operators' experience was measured in years based on the years after completion of fellowship and the date of first embolization, and was divided into five groups: G1, less than 5 years of operator's experience (YOE) at the time of first embolization; G2, 5–10 YOE; G3, 10–15 YOE; G4, 15–20 YOE; and G5, more than 20 YOE. The effects of operator's experience and outcomes were assessed using linear regression.

Results: From January 2012 to January 2015, 93 patients (age range = 30–86 years) were treated. The number of patients treated by each group was as follows: G1 = 12; G2 = 8; G3 = 23; G4 = 5; and G5 = 45. All groups were similar in regard to degree of cirrhosis, Barcelona Clinic Liver Cancer staging, and Child-Pugh score ($P > .05$). Median TLP was 8.8 months. TLP was 7.0, 6.8, 19.2, 7.9, and 8.2 months in G1, G2, G3, G4, and G5, respectively ($P = .56$). OS for 1, 2, and 3 years was 75%, 56%, and 42% for G1; 87%, 54%, and 54% for G2; 91%, 71%, and 45% for G3; 100%, 50%, and 0 for G4; and 84%, 65%, and 40% for G5.

Conclusion: Among interventional radiology fellowship-trained operators in a tertiary cancer center, OS, TLP, and post-procedure complications of TAE were not affected by the years of post-fellowship experience.

Key Words: Hepatic artery embolization; learning curve; hepatocellular carcinoma; operator experience.

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INTRODUCTION

Transarterial hepatic embolization (TAE) and transarterial chemoembolization (TACE) are two minimally invasive procedures that interventional radiologists (IRs) have been using in the past 3–4 decades. Both procedures have been used extensively to treat nonsurgical patients with hepatocellular carcinoma (HCC) (1). TACE has been shown to be safe and effective in improving the overall survival (OS) when compared to best supportive care through randomized clinical trials (2,3). Most recently, in a randomized clinical trial, TAE was compared to doxorubicin-eluting microsphere chemoembolization and the study demonstrated that TAE was as effective and safe as the latter (2).

The principles of how to perform TAE and TACE are part of the teaching curriculum of any IR fellowship training program. The technical success in most interventions is related to skills that are obtained during training and continue to improve after finishing training and during independent practice. IR fellows are trained on how to use wires, microwires, catheters, and microcatheters. Additionally, IR fellows will get educated on principles of embolization and different embolizing options.

Experience from radiofrequency ablation (RFA), another minimally invasive procedure for treatment of HCC, demonstrated a significant learning curve (4,5). Learning curve has been also established with other types of technology-based minimally invasive treatments like laparoscopic surgery (6). Therefore, it can be speculated that such a learning curve also applies to TAE. However, to our best knowledge, there is no published information on the effect of operator experience on the outcomes of TAE in terms of outcomes.

The aim of this study was to evaluate the effect of operator experience on the outcome of TAE in terms of OS, tumor recurrence, and post-procedure complications.

MATERIALS AND METHODS

Patient Selection

Data on patients with HCC who underwent TAE from January 2012 to January 2015 were collected. Only patients whose treatments were performed by a single operator over the course of their disease were included.

Demographic characteristics, tumor size and pattern of involvement, percentage of liver involvement, Child-Pugh score, and Barcelona Clinic Liver Cancer (BCLC) classification were collected. Performance status of the patients was evaluated using the Eastern Cooperative Oncology Group (ECOG) performance status scoring system. Technical aspects of embolization, including the type, size, and volume of embolization material were also collected.

Transarterial Hepatic Embolization Procedure

TAE procedure was performed using the previously described technique (7). Patients were hydrated before the

procedure and received an antiemetic (palonosetron hydrochloride 0.25 mg IV) and antibiotic (cephazolin 1 g IV). Embolization was performed using conscious sedation or general anesthesia. In general, a combination of 40–120 μm , 100–300 μm Embosphere (Merit Medical, South Jordan, UT) and 100 μm polyvinyl alcohol particles (Cook, Bloomington, IN) was used to embolize all the arterial supply to the tumor. Only one lobe was embolized at each treatment session, and, in patients with bilobar disease, the second lobe was treated in 4–6 weeks after the first treatment. Embolization was initiated using the smallest particle (40–120 μm) while the supplying artery was selectively or sub-selectively catheterized. As previously described, embolization was performed until complete stasis was achieved in the supplying vessel. If after using 10 mL of 40–120 μm stasis was not achieved, then the larger size particle (100–300 μm) was used, and this was followed by polyvinyl alcohol particles to achieve complete stasis. Similar technique was used by all the operators.

Operator Experience

From 2012 to 2015, the IR team consisted of 16 attendings (interventional radiology attending [IR MD]). All operators have completed at least a 1-year fellowship in IR. Operator experience was measured in years after completion of IR fellowship and date of first embolization for each patient. Depending on the years of operator's experience (YOE) at the time of the first embolization, the IR MDs were divided into five groups: G1, less than 5 YOE; G2, 5–10 YOE; G3, 10–15 YOE; G4, 15–20 YOE; and G5 more than 20 YOE. Because the YOE was based on the date of first embolization, there was no overlap between the groups.

Outcome

Outcomes analyzed were time to local tumor progression (TLP), local tumor progression free survival, OS, and post-procedure complications rates. Post-procedure complications were graded according to the National Cancer Institute Common Terminology Criteria for Adverse Events, version 4.

Statistical Analysis

Primary end point was OS. Secondary end points were LTP and complications. OS, LTP, and post-procedure complications were assessed using logistic regression. The effects of operator's experience and outcomes were assessed using linear regression. Means were compared using Student *t*. Chi-square was used for categorical variables. Life tables and Kaplan-Meier tables and Mantel-Cox statistics were used for LTP and OS.

Institutional research board approval was obtained for this retrospective study on May 3, 2016.

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