Retrospective Comparative Study to Assess the Safety and Efficacy of Transradial Arterial Access for Hepatic Tumor Embolizations: A Single Operator Experience

Ramanivas Sundareyan[1]   Salil Karkhanis[1]

[1] Department of Interventional Radiology, University Hospitals Birmingham NHS Trust, United Kingdom

Address for correspondence Ramanivas Sundareyan, MBBS, MD, FRCR, EBIR, Consultant Interventional Radiologist, University Hospitals Birmingham NHS Trust, United Kingdom (e-mail: s.ramanivas@gmail.com).

Abstract

Objectives To assess the efficacy and safety of transradial arterial access (TRA) for hepatic tumor embolizations and compare the outcomes between the TRA and transfemoral arterial access (TFA).

Materials and Methods   A retrospective analysis of all consecutive hepatic tumor embolization procedures done through TFA or TRA by a single operator from November 2017 to April 2019 was performed. The procedural variables, including fluoroscopy time, radiation dose (reference air kerma [RAK]), conversion and complication rates, and patient preferences were recorded. The primary endpoint was technical success, which was defined as the successful completion of the embolization procedure. Procedural variables including radiation exposure and patient preferences, and complications were analyzed as secondary endpoints.

Results   Out of 102 procedures in 90 patients, 44 were performed through TFA and the rest by TRA. A technical success rate of 98.2% and a crossover rate of 1.7% were recorded for TRA. There were no major vascular complications and similar rates of minor complications (8.6% for TRA, 2.3% for TFA; $P = 0.055$), without any clinical sequelae. After the initial learning curve, no significant differences for other procedural variables were noted between the two access sites. Faster ambulation were achieved following TRA ($P < 0.055$). All 12 patients who underwent repeat TACE after initial TRA chose this again over TFA.

Conclusions   TRA is safe and effective for hepatic tumor embolization. Its safety and efficacy profile is comparable to that of TFA, with added improved patient comfort and faster ambulation.

Advances in Knowledge   New catheter options and modifications of the existing techniques as explained in this article proved radial arterial access as a safe and effective alternative in hepatic arterial embolization.

Keywords
► chemoembolization
► liver tumors
► transarterial
► transradial

Transarterial embolization for primary and secondary liver tumors is proven as a safe and effective technique.[1,2] Traditionally, these procedures are performed via femoral artery access (TFA) in most cases.[3–5] Transradial arterial access (TRA) has emerged as a valid alternative to TFA in recent times. TRA is widely used in coronary arterial interventions including coronary angioplasty and stenting.[6,7] Earlier ambulation with shorter monitoring post procedure, shorter hospital stay, and potentially reduced bleeding risks make TRA an attractive alternative to TFA. Nevertheless, TRA is under-utilized in non-coronary interventions due to perceived misconceptions such as increased radiation exposure, prolonged procedure time, and inability to manage complex vascular anatomic variations. Further concerns include less familiarity, a longer learning curve, and potentially higher risk for stroke.[8–10] Only limited studies in the literature have compared TRA and TFA in patients undergoing transarterial embolization of hepatic tumours.[11–14] This study aims to assess the efficacy and safety of TRA, and compare it to TFA, as performed by a single operator.

Materials and Methods

This study was a retrospective, single-center comparison of TFA and TRA in patients undergoing transarterial hepatic tumor embolizations. The study was conducted in compliance with the principles and protocols stated in the Declaration of Helsinki, in accordance with the International Conference on Harmonization Harmonized Tripartite Guideline for Good Clinical Practice. The study was also approved by the local ethics committee and the institutional review board.

Written informed consent was obtained from all patients, with a specific mention on the use of TRA. Modified Barbeau's test and ultrasound assessment of the left radial artery diameter were used to select patients for TRA (►Table 1). The initial 10 cases were excluded from the study to allow for procedure standardization and learning curve.

Completing trans-arterial tumor embolization with the first arterial access was defined as a successful technical outcome. Intraprocedural conversion rate, defined as a need for second or an alternative arterial access either due to intraprocedural difficulties or major access site complication was deemed as a technical failure. Adverse events, including access site complications, were assessed according to the Society of Interventional Radiology (SIR) clinical practice guidelines.[15,16] Neurologic events after the procedure, including transient ischemic attacks, reversible ischemic neurologic deficits, and stroke, defined as a new, persistent neurologic disability lasting > 24 hours, were also recorded.

Other procedural variables such as screening time, radiation dose, contrast material volume, were also analyzed as secondary endpoints for comparison. Post procedural ambulation was assessed in angio suite recovery as time from removal of vascular access sheath to ability to ambulate freely.

A subset of patients was asked about preference of vascular access and their response noted in the operation notes. This allowed us to ascertain patient preference for TRA.[17] Verbal confirmation of access site preference in IR recovery done for a subset of patients in the study group (with prior TFA experience, all 4 patients in the group opted for TRA when offered and 12 patients in TRA group chose this when they had repeat TACE).

All embolizations were performed in an angiographic suite using standard procedural criteria as established. This included preprocedural optimization, intraprocedural factors, and postprocedure care.

Radial Access: Left radial artery was always used as the first choice due to its shorter distance to the target vessel and limited the risk of cerebral emboli or thrombus formation.

All procedures were performed in the supine position with left arm adducted and placed over left groin. This allowed easier positioning for cone-beam CT if required. The radial artery was punctured either in the anatomical snuff box or at the styloid level, using ultrasound guidance with 1% lignocaine as local anesthesia. Micropuncture access and the Seldinger technique were used to introduce a 11 cm 4French vascular sheath (Prelude Ease, Merit Medical, USA). Anticoagulant-vasodilator cocktail (2.5 mg of verapamil,

Table 1 Conventional hepatic arterial anatomy from celiac trunk, variant anatomy to include replaced/accessory hepatic arteries

Parameter	TR access ($N = 58$)	TF access ($N = 44$)	P-value
Age (y)	66 (40–83)	69 (42–86)	0.053
M:F	40:6	29:15	0.020
Anatomical variations (conventional: variant arterial anatomy)	46:12	36:9	0.067
No. of lesions (solitary: Multiple)			0.518
Injection points (solitary: multiple)	39:19	33:11	0.676
Fluoroscreening time (min)	15.86 (5.57–35.54)	17.33 (4.33–39.1)	0.639
Patient dose (mGycm^2)	187953 (17242–552534)	167235 (15857–716082)	0.676
Contrast volume (mL)	65 (15–107)	75 (35–140)	0.668
Technical success	57 (58)–98.2%	44(44)-100%	0.165
Complications	5 (58)	1 (44)	0.055

2500 IU Heparin and 200 mcg of glyceryl trinitrate) was given through the sheath after hemodilution to prevent vasospasm and reduce the risk of radial artery occlusion.

A 125 cm long 4F catheter (MPA1, Cordis or Ultimate 1, Merit Medical, USA) was advanced over a 0.035 inch-180 cm hydrophilic wire (Terumo medical, Japan) into the upper abdominal aorta to do selective celiac/superior mesenteric artery cannulation. A 2.7-F microcatheter (Progreat, Terumo Corp) was used co-axially for superselective catheterization into the tumor feeding branches for embolization. Microcatheters with a working length of at least 150 cm were used. Smaller microcatheters were used if super-selective embolization was required.

Reverse curve/Pigtail catheter and exchange length wires were used to cross anatomically difficult aortic arches.

Access sheath was removed following the application of radial safeguard (Merit Medical) with agreed-upon deflation protocol. Deflation was completed in recovery and patients were allowed ambulation after 1 hour once effects of opioid analgesics had worn off. Deflated radial safeguard was left in place overnight to manage any delayed access site bleeding.

Femoral Access: Standard USG-guided retrograde access into the right or left common femoral artery was obtained using a 4 F 11 cm vascular sheath (Cordis). Curved/reverse curved 4F catheters (Cobra 2, Simmonds 2 catheter, Cordis) were used for celiac axis/superior mesenteric artery cannulation. A 2.7 F or smaller microcatheter was used co-axially into the tumor feeding branches for embolization.

Postprocedural hemostasis was achieved with manual compression in all patients except for two patients, in whom 6F angioseal closure device was used. Next, 4 hours flat bed rest followed in the manual compression group and early ambulation (2 hours) in the ward achieved in those with closure devices.

Statistical Analysis

Statistical analysis was performed with IBM SPSS Statistics for Windows Version 25.0 (IBM Corp, Armonk, New York, USA). Data are presented as mean $\pm$ SD. Continuous variables were tested for normality using the Kolmogorov–Smirnov test and were reported as median and range. Comparisons between groups were performed using the Mann–Whitney test for continuous variables and c^2 or Fisher's exact test for categorical data. Differences between two groups were assessed by Student's t-test. $P < 0.05$ considered statistically significant.

Results

During the study period, 102 procedures in 90 patients (69 men, 21 women; mean age 66.3 y $\pm$ 5.9) were identified, with an age range of 40 to 86 years. All procedures were performed by a single experienced interventional radiologist (S.K. with 7 years of experience). All procedures were performed electively. Of the 102 embolizations, 58 were performed by TRA and 44 by TFA.

Various pre- and intra-procedural variables analyzed are listed in ►Table 1. Fluoroscopy time and patient radiation

dose were higher in the TRA group, whereas contrast material volume used was higher in the TFA group, but none of these differences were statistically significant.

Technical success in the TRA group was 98.2% (57/58). In one patient, due to heavily calcified aortic arch, the arterial access had to be converted to a femoral access to allow the procedure to be completed. This gave a crossover rate of 1.7%.

There were no major vascular complications or neurologic events. Six minor complications were observed—4 puncture site hematomas and 1 self-limiting brachial artery spasm in the TRA group (8.6%) and 1 puncture site hematoma in the TFA group (2.3%). All complications were self-limiting without any clinical sequelae and no statistical difference between the two groups (8.6% vs. 2.3%; $P = 0.055$). Though no formal post procedural follow-up USG for radial artery patency was done, in all 12 patients who underwent repeat TRA TACE, the radial arteries were patent and no documentation of left hand ischemia was noted during data collection.

Early mobilization (<1 h) achieved in all patients in TRA group as expected.

A subset of patients was canvassed regarding their preference of vascular access. All four patients who had TFA access prior preferred TRA. Also, 12 patients who had repeat embolizations, during the study period, preferred TRA following previous TRA.

Discussion

Published literature has demonstrated the superiority of TRA compared with TFA for percutaneous coronary interventions, reducing procedure-related bleeding complications and improving patient satisfaction.[8–10] Despite the shift in access site preference among interventional cardiologists in favor of TRA, this technique is not commonly used by interventional radiologists. Only limited studies in the literature explored the use of trans radial access in hepatic trans arterial procedures.[11–14,18–23] Our study, by removing the operator bias, effectively compares the technical efficacy and safety of TRA, in patients undergoing hepatic tumor embolization, with TFA.

Our data demonstrate that hepatic tumor embolization performed through TRA, allows the same degree of efficacy and flexibility as TFA. We noted no significant difference in the ability of TRA access to successfully complete the embolization procedure. There was no observed compromise in the ability to negotiate the anatomical arterial variations seen in the hepatic circulation via TRA compared to TFA. Some of the previously published articles concluded that TRA is technically more challenging, resulting in longer fluoroscopy time and higher radiation dose to the patient.[9,12] In our experience, no statistically significant differences were observed in terms of various procedural variables between TRA and TFA groups. Further, after initial learning curve period we did not observe any significant differences in terms of pre procedural patient preparation time.

Our study did not reveal any major vascular or neurologic complications after TRA with similar rate of minor complications[16] in both access routes. This was recorded in other

studies as well.[12,14,19,24] The use of vascular closure devices potentially reduce time to ambulation for TFA, but additional device related complications and cost[6,17] need to be accounted for. Comparatively, the radial safeguard allows hemostasis without an implanted closure device. Also, it frees up the operator from time spent in manual hemostasis. Our accelerated deflation protocol, lasting an average 20 to 30 minutes, shortened hemostasis time, even compared to femoral vascular closure devices.

All patients in a small subset of our study group, when asked, opted for TRA when repeat TACE procedures done for them.

The main limitation of the present study is its retrospective nature. However, procedures were done by a single operator and a standardized protocol followed in all cases, hence, this might negate the bias. Another potential limitation could be the lack of appropriate neurologic follow-up to detect subclinical neurologic events. However, recent literature on the use of TRA for neurological interventions has established safety in this regard.[25]

Based on its advantages, TRA seems to be a promising alternative as a primary arterial access compared with TFA for hepatic trans-arterial procedures.

In conclusion, this study confirms that TRA is as safe and effective for transarterial hepatic tumor embolization, as is TFA. TRA provides improved patient comfort, allows early ambulation, and is associated with higher patient preference. Future randomized prospective studies performed on larger populations, involving specific clinical scenarios, will be required, to thoroughly evaluate the effect of the arterial access choice on clinical outcomes.

Conflict of Interest
None declared.

References

1 Sieghart W, Hucke F, Peck-Radosavljevic M. Transarterial chemoembolization: modalities, indication, and patient selection. J Hepatol 2015;62(05):1187–1195

2 Del Prete M, Fiore F, Modica R, et al; Multidisciplinary Group for NeuroEndocrine Tumors of Naples. Hepatic arterial embolization in patients with neuroendocrine tumors. J Exp Clin Cancer Res 2014;33:43

3 Brown DB, Cardella JF, Sacks D, et al. Quality improvement guidelines for transhepatic arterial chemoembolization, embolization, and chemotherapeutic infusion for hepatic malignancy. J Vasc Interv Radiol 2006;17(2 Pt 1):225–232

4 Rammohan A, Sathyanesan J, Ramaswami S, et al. Embolization of liver tumors: Past, present and future. World J Radiol 2012;4(09):405–412

5 Miraglia R, Pietrosi G, Maruzzelli L, et al. Efficacy of transcatheter embolization/chemoembolization (TAE/TACE) for the treatment of single hepatocellular carcinoma. World J Gastroenterol 2007;13(21):2952–2955

6 Almeida MH, Meireles GCX, Siva EV, et al. Percutaneous coronary intervention using the radial and femoral approaches: comparison between procedure-related discomforts and costs. Rev Bras Cardiol Invasiva 2013;21:373–377

7 Kiemeneij F, Laarman GJ, Odekerken D, Slagboom T, van der Wieken R. A randomized comparison of percutaneous transluminal coronary angioplasty by the radial, brachial and femoral

approaches: the access study. J Am Coll Cardiol 1997;29(06):1269–1275

8 Jolly SS, Yusuf S, Cairns J, et al; RIVAL trial group. Radial versus femoral access for coronary angiography and intervention in patients with acute coronary syndromes (RIVAL): a randomised, parallel group, multicentre trial. Lancet 2011;377(9775):1409–1420

9 Romagnoli E, Biondi-Zoccai G, Sciahbasi A, et al. Radial versus femoral randomized investigation in ST-segment elevation acute coronary syndrome: the RIFLE-STEACS (Radial Versus Femoral Randomized Investigation in ST-Elevation Acute Coronary Syndrome) study. J Am Coll Cardiol 2012;60(24):2481–2489

10 Bernat I, Horak D, Stasek J, et al. ST-segment elevation myocardial infarction treated by radial or femoral approach in a multicenter randomized clinical trial: the STEMI-RADIAL trial. J Am Coll Cardiol 2014;63(10):964–972

11 Shiozawa S, Tsuchiya A, Endo S, et al. Transradial approach for transcatheter arterial chemoembolization in patients with hepatocellular carcinoma: comparison with conventional transfemoral approach. J Clin Gastroenterol 2003;37(05):412–417

12 Kis B, Mills M, Hoffe SE. Hepatic radioembolization from transradial access: initial experience and comparison to transfemoral access. Diagn Interv Radiol 2016;22(05):444–449

13 Bishay VL, Biederman DM, Ward TJ, et al. Transradial approach for hepatic radioembolization: initial results and technique. AJR Am J Roentgenol 2016;207(05):1112–1121

14 Wu T, Sun R, Huang Y, et al. Transradial arterial chemoembolization reduces complications and costs in patients with hepatocellular carcinoma. Indian J Cancer 2015;52(Suppl 2):e107–e111

15 Omary RA, Bettmann MA, Cardella JF, et al; Society of Interventional Radiology Standards of Practice Committee. Quality improvement guidelines for the reporting and archiving of interventional radiology procedures. J Vasc Interv Radiol 2003;14(9 Pt 2):S293–S295

16 US Department of Health and Human Services National Institutes of Health National Cancer Institute. Common Terminology Criteria for Adverse Events, v4.03. 2010 Accessed April 3, 2017 at: https://evs.nci.nih.gov/ftp1/   CTCAE/CTCAE_4.03_2010–06--14_QuickReference_8.5x11.pdf

17 Cooper CJ, El-Shiekh RA, Cohen DJ, et al. Effect of transradial access on quality of life and cost of cardiac catheterization: A randomized comparison. Am Heart J 1999;138(3 Pt 1):430–436

18 Titano JJ, Biederman DM, Marinelli BS, et al. Safety and feasibility of transradial access for visceral interventions in patients with thrombocytopenia. Cardiovasc Intervent Radiol 2016;39(05):676–682

19 Posham R, Biederman DM, Patel RS, et al. Transradial approach for noncoronary interventions: a single-center review of safety and feasibility in the first 1,500 cases. J Vasc Interv Radiol 2016;27(02):159–166

20 Resnick NJ, Kim E, Patel RS, Lookstein RA, Nowakowski FS, Fischman AM. Uterine artery embolization using a transradial approach: initial experience and technique. J Vasc Interv Radiol 2014;25(03):443–447

21 Ruzsa Z, Tóth K, Jambrik Z, et al. Transradial access for renal artery intervention. Interv Med Appl Sci 2014;6(03):97–103

22 Biederman DM, Marinelli B, O'Connor PJ, et al. Transradial access for visceral endovascular interventions in morbidly obese patients: safety and feasibility. J Vasc Access 2016;17(03):256–260

23 Bhatia S, Harward SH, Sinha VK, Narayanan G. Prostate artery embolization via transradial or transulnar versus transfemoral arterial access: technical results. J Vasc Interv Radiol 2017;28(06):898–905

24 Yuan DZ, Brooks M, Dabin B, Higgs E, Hyun K, Brieger D. Radial versus femoral access for cardiac catheterisation: impact on quality of life. Int J Cardiol 2015;178:91–92

25 Joshi KC, Beer-Furlan A, Crowley RW, Chen M, Munich SA. Transradial approach for neurointerventions: a systematic review of the literature. J Neurointerv Surg 2020;12(09):886–892