The European Research Journal 2025;11(2):387-394 Original Article

DOI: https://doi.org/10.18621/eurj.1624900 *Radiology*

Radiation dose comparison of transradial and transfemoral access in transarterial radioembolization and chemoembolization

Yeliz Basar[1], Mustafa Ege Seker[2], Koray Guven[3]

[1]Department of Radiology, Acibadem Healthcare Group, Istanbul, Türkiye; [2]Department of Radiology, University of Wisconsin-Madison, School of Medicine, Madison, Wisconsin, USA; [3]Department of Radiology, Acibadem Mehmet Ali Aydinlar University, School of Medicine, Istanbul, Türkiye

ABSTRACT

Objectives: To compare radiation doses associated with transradial access (TRA) and transfemoral access (TFA) in transarterial chemoembolization (TACE) and transarterial radioembolization (TARE) procedures for hepatic cancers.

Methods: This retrospective, single-center study analyzed 119 patients who underwent TACE or TARE between October 2016 and October 2024. Radiation dose parameters were compared between TRA and TFA groups, including fluoroscopy time, fluoroscopy and fluoroscopy-digital radiography combined dose-area product (DAP), and total air kerma (AK). Statistical analyses were performed using the Mann-Whitney U test and Chi-squared test.

Results: TRA was associated with significantly higher radiation exposure compared to TFA, including increased fluoroscopy time (median: 15.2 vs. 8.9 minutes, P<0.001), fluoroscopy DAP (median: 84.4 vs. 45.2 Gy·cm², P<0.001), fluoroscopy-digital radiography combined DAP (median: 246 vs. 156.5 Gy·cm², P=0.003), and AK (median: 959 vs. 612.9 mGy, P=0.001). No significant differences were observed in patient demographics, tumor localization, or treatment approach between the groups.

Conclusions: TRA is associated with higher radiation exposure compared to TFA in TACE and TARE procedures. While TRA offers procedural benefits, further research is needed to optimize techniques and reduce radiation risks, particularly in interventional radiology.

Keywords: Transarterial radioembolization, transarterial chemoembolization, transfemoral access, transradial access, radiation dose

Transarterial chemoembolization (TACE) is a widely accepted treatment for unresectable hepatic cancers, traditionally performed through transfemoral access (TFA) [1]. Recently, transradial access (TRA) has gained attention for its potential advantages, including reduced bleeding risk, shorter recovery times, and improved patient comfort [2]. However, TRA also presents challenges, such as radial artery occlusion (RAO) and concerns regarding radiation exposure, which may complicate its application in interventional radiology [3].

Following the established role of TACE in the

Corresponding author: Yeliz Basar, MD.,
Phone: +90 444 55 44, E-mail: yb772@hotmail.com

How to cite this article: Basar Y, Seker ME, Guven K. Radiation dose comparison of transradial and transfemoral access in transarterial radioembolization and chemoembolization. Eur Res J. 2025;11(2):387-394. doi: 10.18621/eurj.1624900

Received: January 22, 2025
Accepted: February 9, 2025
Published Online: February 10, 2025

treatment of hepatic cancers, transarterial radioembolization (TARE) has emerged as an alternative locoregional therapy, particularly for patients who are not candidates for TACE or those with advanced disease features such as portal vein thrombosis [4]. TARE involves the administration of radioactive microspheres, typically loaded with yttrium-90 (Y-90), directly into the hepatic artery to deliver targeted radiation to the tumor. Unlike TACE, TARE does not rely on arterial embolization, which allows for better tolerability in patients with compromised liver function [5]. Recent advancements in interventional radiology, including the use of TRA, have also been explored in TARE procedures, offering potential benefits such as reduced bleeding risk, shorter recovery times, and improved patient comfort [6].

In the context of TARE and TACE, TRA offers potential benefits over TFA, particularly in reducing access site-related complications. However, the application of TRA in non-coronary procedures remains underexplored, particularly regarding its impact on radiation exposure during interventions [7].

This study aims to compare the radiation doses associated with TRA and TFA in TARE and TACE procedures, providing insights into their respective advantages and limitations.

METHODS

Study Sample

The review board approved this retrospective study and granted a waiver for informed consent regarding the collection, analysis, and presentation of anonymized medical data. This study adheres to the STROBE guidelines for reporting.

We retrospectively reviewed consecutive patients who underwent TARE or TACE procedures between October 2016 and October 2024. A total of 119 patients underwent TARE or TACE review. From 119 patients all of them were included in the study. The flowchart of the study is given in Fig. 1.

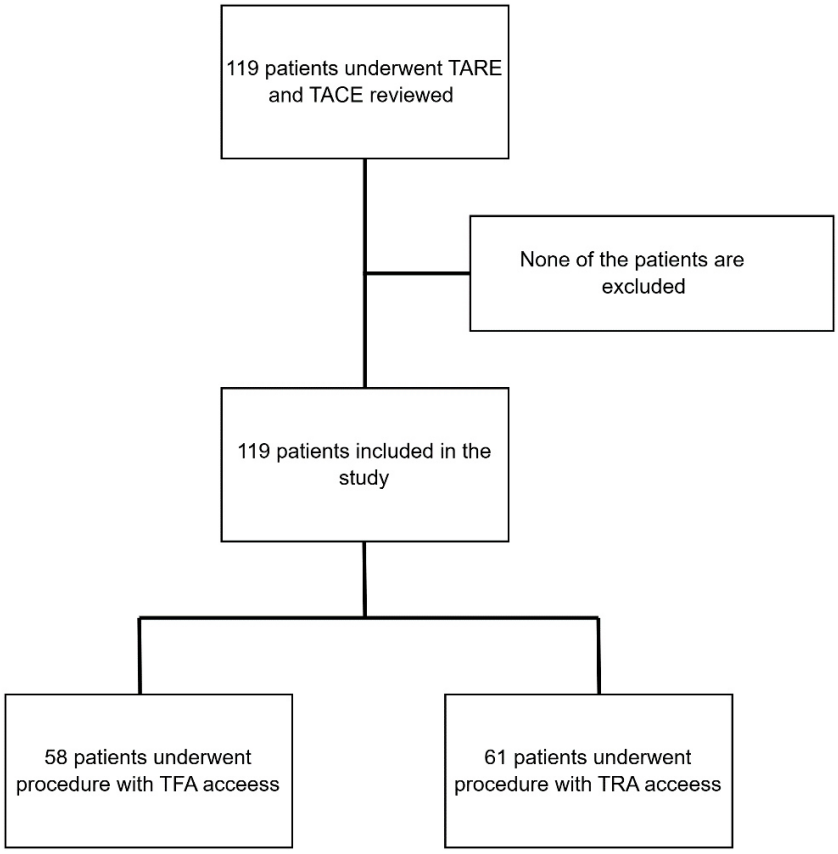

Fig. 1. Flowchart of the study. TARE=transarterial radioembolization, TACE=transarterial chemoembolization, TFA=transradial access, TRA=transfemoral access

Procedure

Prior to the procedure, each patient underwent a 99m Technetium macro aggregated albumin (99mTc-MAA) planning-mapping celiac-mesenteric angiography. If the treatment was planned for both sides of the liver, both sides were assessed separately. TFA or TRA access was assessed with the modified Allen test with a pulse oximeter and radial artery evaluation. Patients with negative Allen test or with radial artery diameter smaller than 2.5 mm, were planned for TFA. Two different vendor cone beam CT scans (Axiom Artis Cath/Angio System, Siemens, Germany; Azurion, Philips, Amsterdam, Netherlands) were performed during angiography for all patients. Tumor localization was done with a 2.4 Fr Progreat microcatheter (Terumo Medical Corporation, Somerset, NJ, USA) in all procedures. Arterial access was reassessed for the treatment session as previously.

For the TARE procedure, treatment dosing was calculated and designed with Simplicit90Y software (Boston Scientific Corp., Marlborough, MA). Y-90 glass microspheres with 20 micrometer diameter (Boston Scientific Corp., Marlborough, MA, USA) were used as the radioembolization agent. After that catheters were removed, and all contaminated materials were disposed of in accordance with institutional radiation safety guidelines. Following the administration of the radiation dose, patients underwent a CT scan to assess the distribution and coverage of the microsphere dose.

For the TACE treatment, a Beacon Tip 5 Fr multipurpose angiographic catheter (Cook Medical, Bloomington, IN, USA) was used. A solution of 2.5 mg of verapamil, 200 mcg of Nitroglycerin, 2 mL of 2% lidocaine, and 2000 IU of heparin was administered for vasospasm and clot formation. A 4F×125 cm Ultimate 1 Performa catheter was then advanced into the abdominal aorta over a 0.038-inch×180 cm Glide wire with a 1.5 mm J-tip. Super selective catheterization was achieved by advancing a 2.7-F microcatheter into the hepatic artery supplying the tumors. Embolization was carried out using an emulsion of calibrated microspheres LifePearl (Terumo Medical Corporation, Somerset, NJ, USA) loaded with doxorubicin 50 mg. The doses of the chemotherapeutic agents used for embolization were tailored to the tumor and patient conditions.

All procedures were carried out by a single interventional radiologist with 20 years of experience in hepatic embolization. Cone beam CT vendor-specific dose reduction software (syngo DynaCT, Siemens, Germany; ClarityIQ, Philips, Amsterdam, Netherlands) and maximum operation room shielding were used. Diagnostic CTs were not included in radiation dosing calculations, and they were taken after standard run-offs. For patients opting for sedation, procedures were performed under standard institutional protocols. Only liver fluoroscopy dose-area product values were extracted for comparison.

Radial Access

For all TRA procedures, the left arm of the patient was positioned alongside the body, and under ultrasound guidance radial artery was accessed. 3000 IU of heparin was administered. A 5 F angiographic Optitorque catheter (Terumo Medical Corporation, Somerset, NJ, USA) was used. Upon completion, a compression device (Terumo Interventional Systems) with an 18 mL air capacity was placed on the wrist, with the balloon positioned over the access site, and inflated as the vascular sheath was withdrawn. The band remained inflated for 30 minutes, after which 2 mL of air was released every 5 minutes. The wristband was removed 60 minutes after initial placement, and the access site was covered with a sterile dressing. Post-procedure, bed rest was not necessary; patients were allowed to sit up and use the bathroom, and they were discharged within two hours.

Femoral Access

For all TFA, the right or left femoral artery was accessed using ultrasound guidance and the Seldinger technique. 3000 IU of heparin was administered. Upon completion of the TFA procedures, manual compression was applied to the femoral artery entry site to achieve hemostasis. Once bleeding was controlled, a sterile compression hemostasis bandage was applied, and a sandbag was placed over the site for six hours. After this period, the patient was assessed and encouraged to ambulate, with plans for discharge.

Statistical Analysis

All analyses were performed using the R statistical software (Austria, R Core Team, version 4.1.0). A confidence level of 0.95 was considered statistically significant. Data normality was evaluated using the

Table 1. Characteristics of the patient group and treatment

Categories		Transfemoral Access (n=58)	Transradial Access (n=61)	P value
Sex, n (%)	Female	23 (39.6%)	25 (41%)	1
	Male	35 (60.4%)	36 (59%)	
Age (year)		60 (17.25)	60 (11)	0.53
Procedure type, n (%)	TARE	53 (91.4%)	144 (89.5%)	**0.01**
	TACE	5 (8.6%)	17 (10.5%)	
Cone beam CT vendor, n (%)	Siemens	38 (65.5%)	33 (54.1%)	0.27
	Philips	20 (34.5%)	28 (45.9%)	
Tumor localization, n (%)	Lobar	47 (81.1%)	49 (80.3%)	1
	Segmental	11 (18.9%)	12 (19.7%)	
Treatment approach, n (%)	Focal	6 (10.3%)	11 (18%)	0.34
	Multifocal	52 (89.7%)	50 (82%)	
Coiling, n (%)		5 (8.6%)	6 (9.8%)	0.93

Data are shown as median (IQR) or n (%). CT=computed tomography

Kolmogorov-Smirnov test, along with skewness and kurtosis values. Variables that did not meet normality assumptions were described using the median and interquartile range (IQR). Categorical and ordinal variables were reported as absolute frequencies.

Differences between age, median fluoroscopy time, median fluoroscopy dose-area product value, median fluoroscopy and digital radiography combined dose-area product value, total air kerma in access site groups were analyzed with Mann-Whitney U Test. Differences between group distribution differences of sex, TARE and TACE, coiling status, tumor localization and treatment approach were analyzed with Chi-Squared test.

RESULTS

From included 119 patients with a mean age of 61.1±10.8 years, 48 (40.3%) of them were females and 71 (59.7%) of them were males. Demographic and treatment characteristics of the TRA and TFA patients are given in Table 1. Three cases continued with femoral access, started with radial in planning-mapping celiac-mesenteric angiography phase due to thrombose formation in radial artery. No further complications were seen in any patients. No statistically significant difference of sex distribution and age was found between the TRA and TFA groups (P=1 and P=0.53, respectively) (Fig. 2). There was a statistically significant difference in procedure type distribution between TRA and TFA groups (P=0.01). There were

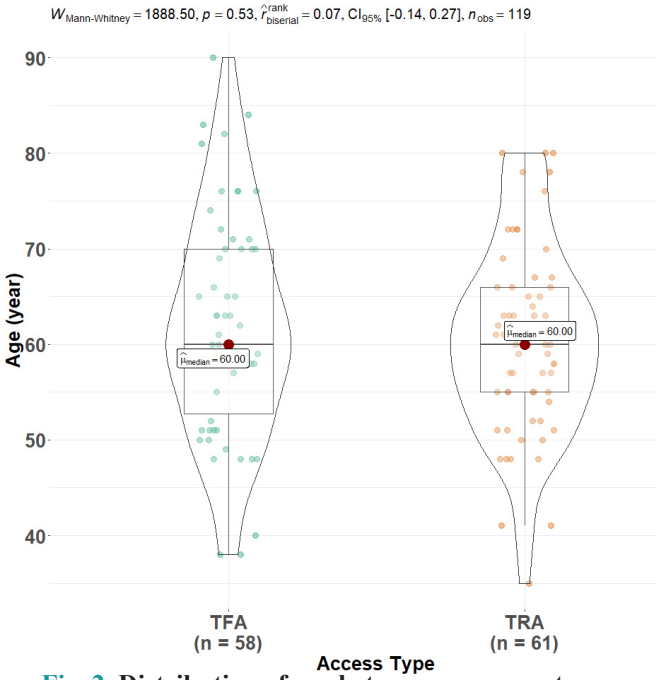

Fig. 2. Distribution of age between access routes.

Table 2. Characteristics of radiation dose parameters between access routes

Categories	Transfemoral Access (n=58)	Transradial Access (n=61)	P value
Median fluoroscopy time (minutes)	8.9 (9.5)	15.2 (14.9)	**<0.001**
Median fluoroscopy dose-area product value (Gy·cm²)	45.2 (45.3)	84.4 (115.9)	**<0.001**
Median fluoroscopy and digital radiography combined dose-area product value (Gy·cm²)	156.5 (142.1)	247 (227.5)	**0.003**
Total air kerma (mGy)	612.9 (730.5)	959 (1202)	**0.001**

Data are shown as median (IQR)

no statistically significant differences in cone beam CT vendor, tumor localization, treatment approach, and coiling status between TRA and TFA groups (P=0.27, P=1, P=0.34, and P=0.93; respectively). Details of radiation dose parameters between access routes were given in Table 2. Median TFA median fluoroscopy time was 8.9 minutes (IQR, 9.5), statistically significantly different than TRA (median:15.2, IQR:14.9, P<0.001). The median of TFA median fluoroscopy dose-area product value (DAP) was 45.2 Gy·cm² (IQR, 45.3), statistically significantly different than TRA (median:84.4 Gy·cm², IQR:115.9, P<0.001). Median of TFA median fluoroscopy and digital radiography combined DAP was 156.5 Gy·cm² (IQR, 142.1), statistically significantly different than TRA (median:247 Gy·cm², IQR:227.5, P=0.003) (Fig. 3). Median of total air kerma (kinetic energy transferred per unit mass) (AK) was 612.9 mGy (IQR, 730.5), statistically significantly different than TRA (median:959 mGy, IQR:1202, P=0.001) (Fig. 4).

DISCUSSION

The study explores the comparative advantages and limitations of TRA and TFA in TACE and TARE pro-

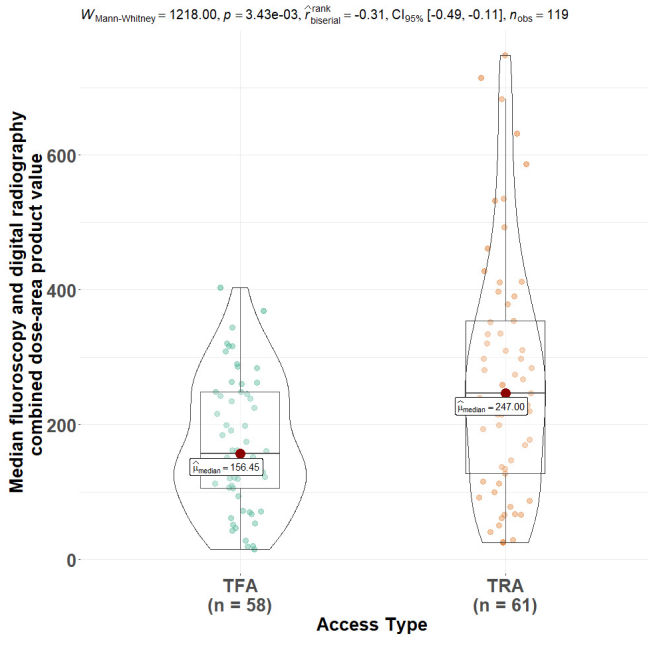

Fig. 3. Distribution of median fluoroscopy and digital radiography combined dose-area product value (Gy·cm²) between access routes.

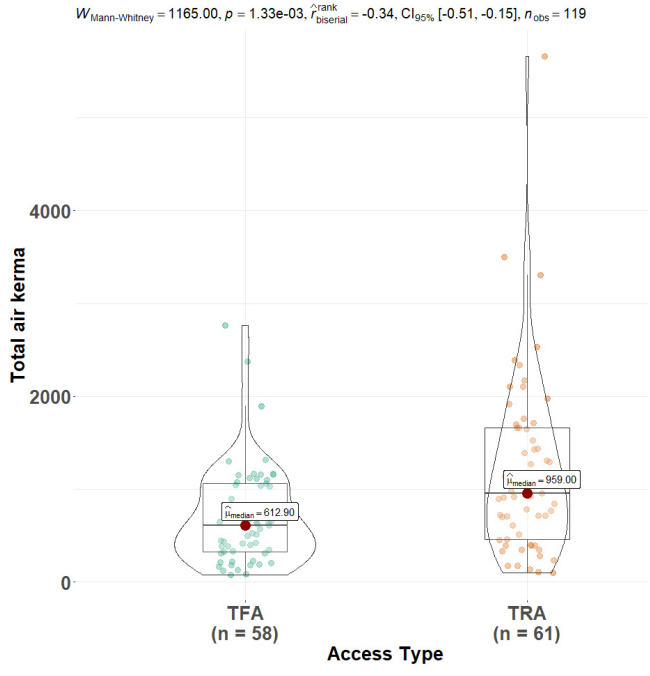

Fig. 4. Distribution of total air kerma (mGy) between access routes.

cedures for hepatic cancers. The retrospective analysis of 119 patients revealed no significant differences in demographic characteristics or tumor localization between TRA and TFA groups. However, TRA was associated with significantly higher fluoroscopy time, DAP, and total AK compared to TFA, indicating increased radiation exposure. Despite these findings, TRA remains a promising alternative to TFA, particularly for reducing access site complications, though its impact on radiation exposure warrants further investigation. This study highlights the need for a balanced approach when selecting access routes, considering both procedural safety and radiation risks.

When comparing TACE and TARE, both treatments exhibit similar effectiveness and toxicity profiles; however, TARE has demonstrated a longer time-to-progression and reduced toxicity, despite no significant differences in overall survival rates [8, 9]. Factors such as tumor multifocality, vascular invasion, and hepatitis C seropositivity have been linked to poorer survival outcomes, regardless of the treatment method employed for hepatocellular carcinoma [9].
Recent studies comparing TRA and TFA in TARE and TACE procedures have yielded mixed results. For instance, Loewenstern *et al*. found no significant differences in patient radiation exposure between TRA and TFA during Y-90 radioembolization [10]. Conversely, Pedersoli *et al*. [11] reported significantly higher operator radiation exposure with TRA compared to TFA, particularly noting higher rates of exposure per fluoroscopy time. Jiang *et al*. [12] found that the radiation doses received by the operator at various body parts were lower in the TRA group, especially when the left radial artery was accessed with the patient in a feet-first position. However, Sciahbasi *et al*. [13] also noted higher radiation doses in the TRA group during hepatic radioembolization.

Regarding patient radiation doses, multiple studies have found no significant differences between TRA and TFA. For example, a propensity score-matched analysis showed no statistical differences in fluoroscopy time, DAP, or cumulative AK between the two access methods [14]. However, some studies reported higher patient radiation doses with TRA, particularly during hepatic radioembolization [13].

Procedural variables also play a crucial role in the comparison of TRA and TFA. While some studies indicate that fluoroscopy time is generally longer for TRA [10, 13], others have found no significant differences [14]. Both access methods demonstrate high technical success rates and similar complication rates, with TRA often preferred by patients for its comfort and reduced postprocedural stay [11, 15, 16].

The observed higher radiation exposure associated with TRA compared to TFA in this study may be attributed to several procedural and anatomical factors inherent to the two access routes. First, the radial artery's smaller diameter and more tortuous course compared to the femoral artery often necessitate increased fluoroscopy time for precise catheter navigation and positioning. This is particularly relevant during complex hepatic interventions such as TACE and TARE, where super-selective catheterization of small hepatic arteries is required. Additionally, the need for repeated adjustments and repositioning of catheters and guidewires during TRA can further contribute to prolonged fluoroscopy use [17]. Second, the ergonomic setup during TRA procedures may also play a role; operators often adjust the C-arm angulation or patient positioning to accommodate the radial approach, which can inadvertently increase scatter radiation and overall dose exposure. Third, the learning curve associated with adopting TRA for non-coronary interventions, such as TACE and TARE, might result in less efficient techniques compared to the well-established TFA. Studies have shown that operator experience significantly influences radiation doses, with less experienced operators tending to require longer fluoroscopy times and more frequent acquisitions [18].

Limitations

This study has several limitations. First, the relatively low number of TACE cases included may limit the generalizability of the findings, particularly when comparing radiation exposure between TRA and TFA in this subgroup. Second, the retrospective, single-center design may introduce selection bias and limit the applicability of the results to broader populations or different clinical settings. Future multicenter, prospective studies with larger sample sizes and multi-operator are needed to validate these findings and provide a more comprehensive understanding of the radiation dose differences between TRA and TFA.

CONCLUSION

In conclusion, this study demonstrates that TRA is associated with significantly higher radiation exposure compared to TFA, as evidenced by increased fluoroscopy time, DAP, and AK. These findings emphasize the need for further research to optimize TRA techniques and minimize radiation risks, ensuring its safe application in interventional radiology.

Ethical Statement

All procedures conducted in studies involving human participants complied with the ethical standards of the institutional and/or national research committee, as well as the 1964 Helsinki Declaration and its subsequent amendments or equivalent ethical guidelines. The local ethics committee approved this retrospective study and waived the requirement for informed consent for the retrospective analysis of anonymized medical data (Decision number: 2024-14/576 and date: 19.09.2024).

Data availability

The data sets produced and/or examined over the course of the present investigation can be obtained from the lead author upon a justified request.

Authors' Contribution

Study Conception: YB, KG; Study Design: YB, KG; Supervision: YB; Funding: N/A; Materials: N/A; Data Collection and/or Processing: YB, MG; Statistical Analysis and/or Data Interpretation: YB, MES; Literature Review: YB; Manuscript Preparation: YB and Critical Review: YB, MES, KG.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

Financing

The authors disclosed that they did not receive any grant during conduction or writing of this study.

REFERENCES

1. Manjunatha N, Ganduri V, Rajasekaran K, Duraiyarasan S, Adefuye M. Transarterial Chemoembolization and Unresectable Hepatocellular Carcinoma: A Narrative Review. Cureus. 2022;14(8):e28439. doi: 10.7759/cureus.28439.
2. Du N, Yang MJ, Ma JQ, et al. Transradial access chemoembolization for hepatocellular carcinoma in comparation with transfemoral access. Transl Cancer Res. 2019;8(5):1795-1805. doi: 10.21037/tcr.2019.08.40.
3. Ali S, Abdullah MS, Abdelrahman K, Ali A, Faisal F, Ali A. Total Radial Artery Occlusion Following Transradial Access: Complete Recanalization via the Anatomical Snuffbox. Methodist Debakey Cardiovasc J. 2020;16(4):314-317. doi: 10.14797/mdcj-16-4-314.
4. Brown AM, Kassab I, Massani M, et al. TACE versus TARE for patients with hepatocellular carcinoma: Overall and individual patient level meta analysis. Cancer Med. 2023;12(3):2590-2599. doi: 10.1002/cam4.5125.
5. Reincke M, Schultheiss M, Doppler M, et al. Hepatic decompensation after transarterial radioembolization: A retrospective analysis of risk factors and outcome in patients with hepatocellular carcinoma. Hepatol Commun. 2022;6(11):3223-3233. doi: 10.1002/hep4.2072.
6. Mikell JK, Dewaraja YK, Owen D. Transarterial Radioembolization for Hepatocellular Carcinoma and Hepatic Metastases: Clinical Aspects and Dosimetry Models. Semin Radiat Oncol. 2020;30(1):68-76. doi: 10.1016/j.semradonc.2019.08.005.
7. 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(3):256-260. doi: 10.5301/jva.5000530.
8. Salem R, Lewandowski RJ, Kulik L, et al. Radioembolization results in longer time-to-progression and reduced toxicity compared with chemoembolization in patients with hepatocellular carcinoma. Gastroenterology. 2011;140(2):497-507.e2. doi: 10.1053/j.gastro.2010.10.049.
9. Kooby DA, Egnatashvili V, Srinivasan S, et al. Comparison of yttrium-90 radioembolization and transcatheter arterial chemoembolization for the treatment of unresectable hepatocellular carcinoma. J Vasc Interv Radiol. 2010;21(2):224-230. doi: 10.1016/j.jvir.2009.10.013.
10. Loewenstern J, Welch C, Lekperic S, et al. Patient Radiation Exposure in Transradial versus Transfemoral Yttrium-90 Radioembolization: A Retrospective Propensity Score-Matched Analysis. J Vasc Interv Radiol. 2018;29(7):936-942. doi: 10.1016/j.jvir.2018.02.011.
11. Pedersoli F, Fang J, Boas E, Park JJ. Operator radiation exposure during radioembolisation of the liver: transfemoral versus transradial access using real-time dose monitoring. Radiat Prot Dosimetry. 2023;199(19):2344-2348. doi: 10.1093/rpd/ncad236.
12. Jiang H, Chen Y, Liao H, Gu Y, Meng X, Dong W. Operator radiation dose during trans-hepatic arterial chemoembolization: different patients' positions via transradial or transfemoral access. Diagn Interv Radiol. 2022;28(4):376-382. doi: 10.5152/dir.2022.211327.
13. Sciahbasi A, Rigattieri S, Sarandrea A, et al. Determinants of operator radiation exposure during percutaneous coronary procedures. Am Heart J. 2017;187:10-18. doi: 10.1016/j.ahj.2017.02.012.
14. Yamada R, Bracewell S, Bassaco B, et al. Transradial Versus

Transfemoral Arterial Access in Liver Cancer Embolization: Randomized Trial to Assess Patient Satisfaction. J Vasc Interv Radiol. 2018;29(1):38-43. doi: 10.1016/j.jvir.2017.08.024.
15. Ghosh A, Gupta V, Al Khalifah A, Akhter NM. Transradial versus transfemoral arterial access in DEB-TACE for hepatocellular carcinoma. J Clin Imaging Sci. 2022;12:38. doi: 10.25259/JCIS_47_2022.
16. Khayrutdinov ER, Рафаилович ХЕ, Gromov DG, Геннадьевич ГД, Arablinskiy AV, Владимирович АА. The comparative analysis of transradial and transfemoral vascular approaches for chemoembolization of pancreatic cancer. Russian J Oncol. 2021;26(5):155-162.
17. Jolly SS, Cairns J, Niemela K, et al; RIVAL Investigators. Effect of radial versus femoral access on radiation dose and the importance of procedural volume: a substudy of the multicenter randomized RIVAL trial. JACC Cardiovasc Interv. 2013;6(3):258-266. doi: 10.1016/j.jcin.2012.10.016.
18. Sciahbasi A, Frigoli E, Sarandrea A, et al. Radiation Exposure and Vascular Access in Acute Coronary Syndromes: The RADMatrix Trial. J Am Coll Cardiol. 2017;69(20):2530-2537. doi: 10.1016/j.jacc.2017.03.018.