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INTERVENTIONAL RADIOLOGY

ORIGINAL ARTICLE

Hepatic radioembolization from transradial access: initial experience and comparison to transfemoral access

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PURPOSE
Despite the growing evidence in the cardiology literature that transradial approach has substantial benefits over transfemoral access, this technique is rarely used during interventions in the systemic circulation. The aim of this study was to evaluate the feasibility of transradial approach for hepatic radioembolization and to compare it with transfemoral approach.

METHODS
Sixty-four hepatic radioembolizations performed in 50 patients were included in the study. Thirty-three procedures were performed via radial access in 27 patients, and 31 procedures were performed via femoral access in 23 patients.

RESULTS
There was 100% technical success in performing hepatic radioembolization in both groups. The majority (97%) of the patients who underwent transradial radioembolization reported preference for radial artery access. The fluoroscopy time was significantly longer (9.45±5.09 min vs. 5.72±3.67 min, $P < 0.01$) and the radiation dose was significantly higher (597.8±585.2 mGy vs. 302.8±208.3 mGy, $P < 0.01$) in the radial group compared with the femoral group. The direct cost savings using radial access versus femoral access is approximately $100/procedure. In addition, there was a one hour (50%) shorter postprocedural stay for patients who underwent the transradial procedure.

CONCLUSION
Transradial access is feasible for hepatic radioembolization. The transradial approach is cheaper and offers improved patient comfort. However, it is technically challenging, with longer fluoroscopy times and higher radiation doses. Transradial approach should be considered as a primary choice in patients with low platelet count and/or morbid obesity. Transradial access should be in the procedural repertoire of every interventional radiologist.

Transarterial radioembolization with yttrium-90 (Y90) labeled microspheres is an emerging therapy for hepatocellular carcinoma (1), intrahepatic cholangiocarcinoma (2), and liver dominant metastatic diseases (3), with reported improved overall survival and favorable tolerability profile. The radioembolization treatment is performed via femoral artery access in the majority of cases. Transradial access is an alternative to the transfemoral approach, and it is commonly used in coronary angiographies and interventions. However, it is rarely used during interventions in the systemic circulation.

The utilization of radial access for cardiac procedures has grown exponentially during the last decade (4) due to growing evidence that this technique has substantial benefits over femoral artery access. The radial artery is an ideal vascular access site due to its superficial course over the radius, allowing for easy compressibility. Additionally, there are no major nerves or veins located near the artery. Transradial access has significantly decreased the risk of entry site complications (5–7) and improved postprocedural patient comfort (8, 9). On the other hand, the cardiology literature also describes increased technical difficulty of catheterization from the radial approach with associated longer procedure times, greater radiation dose (10), and a higher likelihood of access failure than the femoral approach (6). These negative facts likely contribute to the reluctance of interventional radiologists to adopt radial access for transarterial procedures in the systemic circulation.

The number of interventional radiologists who regularly use transradial approach is very low. Besides a handful of case reports, there are only a few publications describing regular

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use of radial access for procedures in the systemic circulation (11–15), and the majority of these reports are related to cerebral angiograms and carotid stenting (16, 17). According to our knowledge, there is only one peer-reviewed publication which compares radial to femoral approach for a procedure in the systemic circulation (15); Shiozawa et al. (15) investigated the therapeutic efficacy and safety of the transradial approach for transarterial chemoembolization in patients with hepatocellular carcinoma and compared it with the conventional transfemoral approach. However, there is no available data comparing fluoroscopy time and radiation dose of procedures in the systemic circulation performed via transradial versus transfemoral access.

Here, we report our initial experience and the feasibility of the transradial approach for hepatic radioembolization compared with the transfemoral approach. The fluoroscopy time, radiation dose, patient preference, and economics of the two vascular access approaches for radioembolization were analyzed. We also describe our technique and provide a review of the literature.

Methods

This study was approved by the Institutional Review Board of our hospital. Hepatic radioembolization procedures performed between May 2014 and October 2015 were retrospectively analyzed. All procedures were performed by one interventional radiologist with four years of experience in hepatic embolization procedures. Patients were not specifically selected for femoral or radial access. Hepatic radioembolizations were performed exclusively from femoral access until August 2014. From September 2014 all radioembolizations were performed from radial access if the patient was a candidate for radial access. All patients in both groups underwent a work-up angiogram using transfemoral approach as preparation for the radioembolization approximately two weeks before the actual treatment. The work-up angiograms always include cone beam computed tomography (CT) imaging and currently we are not able to perform cone beam CT imaging during radial access procedure due to patient positioning during the radial access procedures. All procedures were performed under moderate procedural sedation with intravenous administration of midazolam and fentanyl per standard institutional protocol.

Radial access

The completeness of the radio-ulnar palmar arch was evaluated on both hands of every patient who was considered for radial access using the modified Allen's test (17). A pulse oximetry sensor was placed on the thumb, and the ulnar and radial arteries were compressed simultaneously until the pulse oximetry waveform became flat. Next, the ulnar artery was released and if there was normalization of the waveform and restoration of baseline saturation within 10 seconds the radial artery deemed suitable for vascular access. Transradial access was contraindicated if the patient had a positive (abnormal) Allen's test, needed to maintain the radial artery for dialysis access, or had one upper extremity. In addition, patients were not considered for radial artery access if cone beam CT acquisition was planned during the procedure. Three patients could have been candidates for radial access based on Allen's test, but radial access was not performed. One patient was on chronic hemodialysis via a forearm arteriovenous fistula, one patient's proximal left radial artery was harvested for coronary artery bypass and had a positive Allen's test in the right hand, and one patient had only one upper extremity, so we did not accept any risk to potentially damage hand function in the remaining left upper extremity. These patients underwent radioembolization via femoral artery access.

When the right radial artery was accessed the patient was positioned with the right arm next to the body in adducted position, and when the left radial artery was accessed the patient's arm was 80°–90° abducted. This positioning allowed the right-handed operator to use his right hand at the trailing end of the catheters and wires similar to the traditional right femoral access. The respected hand of the patient was then supinated, a small rolled-up towel was placed under the wrist, and the 2–5 fingers were secured to the procedure table with a tape to place the hand in slightly dorsiflexed position. Following sterile prepping and draping of the wrist, the skin was anesthetized with 1% lidocaine, and the radial artery was accessed using the single wall technique with a 21G × 35 mm needle approximately 1 cm proximal to the radial styloid process. Ultrasound guidance was used for the access, if the radial artery puncture was not successful after three attempts using palpation. We used ultrasound for radial access in 30% of cases (10 out of 33 cases). After successful arterial puncture, a 6 French (F) × 10 cm Glidesheath Slender (Terumo Medical) vascular introducer sheath was placed over an 0.021-inch SS microwire (Terumo Medical) without skin incision at the puncture site. The Glidesheath Slender has an outer diameter comparable to conventional 5F sheaths but due to its very thin wall it has a 6F lumen allowing the use of 6F catheters. The reported radial artery occlusion rate was less than 1% using Glidesheath Slender in the study of Aminian et al. (18). Following the insertion, the sidearm of the sheath was connected to slow continuous heparinized saline flush. Vasodilator cocktail containing 2.5 mg verapamil with 100 mg nitroglycerine and 3000 U heparin was diluted up to 20 mL with the patient's blood, and injected via the vascular sheath intra-arterially to prevent vasospasm and reduce the risk of clot formation (17). Following the injection of the vasodilator cocktail, a 5F × 110 cm Optitorque Sarah catheter (Terumo Medical) or a 5F × 125 cm Ultimate 2 Performa catheter (Merit Medical) was advanced into the abdominal aorta over a 0.035-inch × 180 cm Glidewire with a 1.5 mm J-tip. The 5F catheter was used to select the celiac and/or superior mesenteric artery depending on the origin of the target vessel for embolization. The Optitorque Sarah catheter and the Ultimate 2 Performa catheter were designed for coronary artery interventions from radial access. These are braided catheters with excellent torquability. They have a shape most similar to a Cobra-2 catheter allowing selection of abdominal visceral vessels. In addition to their useful shape, these catheters are available in 110 cm and 125 cm lengths, which are necessary for procedures below the diaphragm performed from radial access.

Main points

- Transradial access has substantial benefits over transfemoral access as described in the interventional cardiology literature, but this technique is rarely used by interventional radiologists in the systemic circulation.
- Our study demonstrates that the transradial approach is a viable alternative to femoral access for transarterial hepatic radioembolization with technical success rate of 100% in this series.
- The transradial approach offers earlier ambulation, improved patient comfort and reduced cost, but it is technically more challenging, leading to longer fluoroscopy time and higher radiation dose to the patient.

Femoral access

After local anesthesia with 1% lidocaine, a small skin incision was made at the planned puncture site, and the right common femoral artery was accessed with a 5F micropuncture set (Cook Medical). A 5F × 13 cm vascular sheath was placed over a 0.035-inch × 180 cm Newton wire with 3 mm J-tip (Cook Medical). A 5F Contra catheter (Boston Scientific) was used to select the celiac and/or superior mesenteric artery depending on the origin of the target vessel for embolization.

Radioembolization

A coaxial 2.5F × 150 cm Cantata microcatheter (Cook Medical) or 2.8F × 150 cm Progreat microcatheter (Terumo Medical) over a 0.018-inch × 180 cm glidewire GT microwire (Terumo Medical) was used to select the target hepatic artery branch when the procedure was done from the radial approach. A coaxial 2.8F × 135 cm Cantata microcatheter over a 0.018-inch × 180 cm glidewire GT microwire (Terumo Medical) was used to select the target hepatic artery branch when the procedure was done from the femoral approach. The microcatheter was connected to the Therasphere delivery system, and the Y90 glass microspheres were injected into the targeted hepatic artery. When two target vessels were treated, two separate microcatheters were used. Following administration of the Y90 glass microspheres, the catheters were removed, and all contaminated material was safely discarded according to institutional radiation safety protocol.

Hemostasis

Patients who underwent the radial access procedure had an inflatable wrist band placed over the access site. TR Band (Terumo Medical) with 18 mL air capacity was used in 31 procedures, and SafeGuard Radial Compression Device with 7 mL air capacity (Merit Medical) was used in two cases. The compression devices were placed on the wrist with the balloon positioned over the access site, and they were inflated with air as the vascular sheath was pulled out. To prevent excessive pressure on the radial artery, the band was slowly deflated after the placement to a point in which minimal bleeding was seen from the access site, and 1 mL air was inflated back into the cuff. The band was left in this inflated position for 30 min, and then 2 mL of air was deflated every 5 min from the TR Band, and 1 mL air was deflated in every 5 min from the SafeGuard Radial Compression Device. The band was removed 60 min after the initial placement, and the access site was covered with sterile dressing. Postprocedural bed rest was not required, and the patients were allowed to sit up in the bed and had bathroom privileges. Patients were discharged one hour after the radial access procedure.

In patients who underwent the femoral access procedure, the arterial access was closed with MynxGrip Vascular Closure Device (AccessClosure) and covered with sterile dressing. The patient was ordered two hours of strict bed rest in a flat position. Patients were discharged two hours after the procedure.

Follow-up

All patients had a follow-up four weeks after the radioembolization procedure, in which they underwent a physical exam, including a pulse check at the vascular access site, labs, and cross-sectional imaging. During the follow-up visit, the patients who underwent radioembolization via radial artery access were asked whether they prefer femoral access or radial access for transarterial procedures.

Statistical analysis

Statistical analysis was performed with SigmaStat (version 2.03) statistical software (SPSS Inc.). Data are presented as mean ± standard deviation (SD). Differences between two groups were assessed by Student t-test. $P < 0.05$ was considered to be statistically significant.

Results

During the study period, one interventional radiologist performed 73 radioembolization procedures on 58 patients (11 patients had two radioembolizations and two patients had three radioembolizations). Sixty-four procedures performed in 50 patients were included in the study. Nine femoral access procedures in eight patients were excluded from the study because cone-beam CT was performed during those procedures.

Thirty-three procedures were performed from radial access in 27 patients (15 males, 12 females; mean age, 67.1±10.9 years); four patients underwent two radioembolization procedures approximately 6–8 weeks apart and one patient underwent three radioembolization procedures. Thirty-one procedures were performed from femoral access in 23 patients (15 males, 8 females; mean age, 63±13.9 years); six patients underwent two radioembolization procedures approximately 6–8 weeks apart and one patient underwent three radioembolization procedures. In eight radial access procedures and seven femoral access procedures, two different vascular territories were treated sequentially during the same procedure using two microcatheters.

There was 100% technical success in performing the radioembolization treatment in both groups. There was no switch from radial access to femoral access during any procedure. Ninety-seven percent of patients (32 out of 33) who underwent radioembolization via radial artery access reported that they prefer radial artery access over femoral artery access. The patient who preferred femoral artery access complained of continuous chest pain for weeks after the transradial procedure. The cause of the chest pain was not identified despite extensive diagnostic work-up, including CT angiography of the chest and abdomen, which showed no evidence of aortic dissection or any other vascular complications. All patients underwent planning angiograms approximately 10–14 days before the radioembolizations via femoral access. Therefore, patients in the radial access group experienced both femoral and radial accesses.

The mean fluoroscopy time was 9.45±5.09 min (n=33) in the radial group and 5.72±3.67 min (n=31) in the femoral group, and the difference was statistically significant ($P < 0.01$). The radiation dose was also significantly higher in the radial group compared with the femoral group ($P < 0.01$); the mean radiation dose was 597.8±585.2 mGy (n=33) in the radial group and 302.8±208.3 mGy (n=31) in the femoral group. The body mass index (BMI) was not significantly different between the two groups; the mean BMI was 29.9±5.3 kg/m^2 in the radial group and 29.2±5.1 kg/m^2 in the femoral group.

There were three minor complications in the radial group (9%); three patients developed subcutaneous hematoma in the left forearm at the radial artery puncture site. In the radial group, no signs of hand ischemia or absent radial pulse were observed immediately after the procedure or at the one-month follow-up visit. There was no access site or other complication in the femoral group.

In our institution, the direct cost of the supplies for a radial access procedure (including the medications in the vasodilator cocktail) was $669.10, and the cost of the supplies for the femoral access procedure was $767.40 when one site was treated. The postprocedure care of patients who underwent the femoral access procedure was two hours compared with one hour for patients who underwent radial access, which further decreases the overall cost of the radial access procedure compared with femoral access.

Discussion

Our study demonstrates that transradial approach is a viable alternative to femoral access for transarterial hepatic radioembolization. We found that transradial approach offers earlier ambulation, improved patient comfort, and reduced cost, but it is technically more challenging, leading to longer fluoroscopy time and higher radiation dose to the patient.

Hepatic radioembolization is an outpatient procedure, and early mobility of patients expedites patient discharge, which improves patient comfort, decreases recovery room turnover time, and reduces costs. Radial access as an alternative to femoral access is gaining popularity amongst interventional cardiologists because it is associated with decreased access site complications (5–7), earlier ambulation, improved patient comfort (8, 9) and reduced cost (19). The number of transradial coronary diagnostic and interventional procedures in the United States grew eight-fold between 2007 and 2012, and its utilization increases continuously (20). Although, the first case series using transradial approach for angiograms in the systemic circulation was reported almost 20 years ago (21), interventional radiologists are far behind interventional cardiologists in utilization of radial access. According to our knowledge, there are only a few hospitals where radial access is regularly performed for interventions in the systemic circulation. Most of the related publications report the use of radial access for cerebral angiograms and carotid artery stenting (16, 17) and only a few report procedures below the diaphragm (11–15). Only three groups reported abdominal or pelvic visceral interventions in the English literature. A group at Tokyo Women's Medical University Daini Hospital (Tokyo, Japan) reported that they performed abdominal interventions in 426 patients between 2000 and 2004 via the transradial approach, including 177 cases of transarterial hepatic chemoembolizations (15, 22); Ruzsa et al. (14) reported renal artery angioplasty and stenting in 27 patients; Resnick et al. (13) reported uterine artery embolization in 29 patients.

Shiozawa et al. (15) demonstrated that the therapeutic efficacy and safety of the transradial approach for transarterial chemoembolization of hepatocellular carcinoma is comparable to the conventional transfemoral approach. There is no other report that compares transradial access to transfemoral access for procedures in the systemic circulation.

Our current study explored the feasibility of radial artery access for hepatic radioembolization and compared it with the transfemoral approach. Hepatic radioembolization is an ideal procedure to compare the two vascular access approaches because all patients in both groups underwent a work-up angiogram from transfemoral approach as preparation for the radioembolization approximately two weeks before the actual treatment. This gives the opportunity to evaluate individual patient experience comparing the two vascular access approaches. In addition, we used Y90 labeled glass microspheres (Therasphere) for radioembolization, and the delivery of these beads does not require fluoroscopic monitoring. Radioembolization with Y90 labeled resin microspheres or chemoembolization requires fluoroscopic monitoring of the delivery of the embolic material, which could result in increased variability of required fluoroscopy time between cases depending on the size and vascularity of the target tumor volume.

This study demonstrates that the transradial approach is a viable alternative to femoral access for transarterial hepatic radioembolization with technical success rate of 100% in our series and 0% conversion rate to femoral access. In a larger series, Shiozawa et al. (15) reported that hepatic angiography and transarterial chemoembolization of liver tumors via transradial access were completed in 174 of 177 cases (98.3%). These results are better than the results of interventional cardiology, where the reported conversion rate is as high as 7.2% (6).

There were three minor access site complications following radial access procedure. These complications could be due to lack of experience of the operator related to using radial compression device. There was no complication related to femoral artery access in our relatively small series of patients. However, in a study including 3224 patients, Agostoni et al. (6) reported nine times higher rate of entry site complications for femoral access compared to radial access (2.8% versus 0.3%).

We did not observe radial artery occlusion or signs of hand ischemia in our patients. We performed radial access procedures only in those patients who had negative modified Allen's test, indicating patent radio-ulnar palmar arch. However, based on a recent report, the examination of the radio-ulnar palmar arch is not indicated before radial access because tests of the radio-ulnar palmar arch patency have no predictive value with respect to digital ischemia (5). The general recommendation for radial artery size, which is suitable for access, is at least 2 mm in diameter. In the study of Resnick et al. (13) a radial artery diameter of less than 3 mm was considered a contraindication for vascular access for uterine artery embolization. We did not use a cutoff value for radial artery size in our study, and we did not measure radial artery size in every patient. We used ultrasound guidance for vascular access only in selected patients when the radial artery puncture was not successful after three attempts using palpation. In our practice, the smallest radial artery which was successfully accessed under ultrasound guidance and embolization performed was 1.7 mm.

The real benefit of the radial access is patient comfort. Our patients in the radial access group underwent angiogram via femoral artery access for the work-up angiogram, but the radioembolization treatment was performed from the radial access. The majority of our patients (32 out of 33) preferred radial access over femoral access when they were asked at the one-month follow-up visit. Following transradial access, postprocedural bed rest is not required, permitting immediate ambulation and more comfort for the patients. Our data on this limited number of patients are in accordance with larger scale data in the cardiology literature, which describes improved patient comfort using transradial access (8, 23).

In our institution, the direct cost savings using radial access versus femoral access with the use of closure devices is approximately $100/procedure. In addition, there is 50% shorter postprocedural stay for patients who undergo the transradial procedure (1 hr vs. 2 hrs). It is known from the literature that there is additional significant cost savings due to decreased access site complications during transradial procedures. A systematic review of 14 randomized, controlled trials of coronary interventions reported that the radial approach resulted in $275 cost savings per patient from the hospital's perspective (19). The study considered procedure and hemostasis time, costs of repeating the procedure at an alternative site if the first attempt failed, and the inpatient hospital costs associated with complications arising from the procedure.

Besides the benefits of the transradial access, the cardiology literature describes drawbacks of the procedure including increased technical difficulty of catheterization with associated longer procedure time, greater radiation dose, and higher likelihood of access failure than the femoral approach (6, 7, 10). Previous studies of subdiaphragmatic procedures from radial access did not examine the fluoroscopy time and radiation dose of the procedure. Our study demonstrates that similar to cardiac interventions, the fluoroscopy time was significantly longer when the hepatic radioembolization was performed from radial access compared with femoral access. This is not unexpected since the path of the parent catheter from the access site to the celiac or superior mesenteric artery is approximately four times longer. The much longer parent catheter used for radial approach (110+ cm vs. 65 cm) and the more tortuous course of the catheter from radial access obviously led to reduced pushability and torqueability of the catheters and increased the difficulty in selecting the target vessels. In some cases, the most difficult aspect was to navigate the parent catheter from the subclavian artery into the descending aorta. This depended on the aortic arch tortuosity and whether the orifice of the subclavian artery was pointing towards the ascending or descending aorta. When the parent catheter was in position, navigating the microcatheter over a microwire into branches of the hepatic artery was comparable between the two access approaches. The fluoroscopy time did not improve as we performed more cases, and this does not support the existence of a learning curve in our experience. We found that the fluoroscopy time depended on the patient's anatomy, especially the anatomy of the aortic arch and its great vessels, and it was less dependent upon prior experience. However, this series included only 33 radial procedures, and the reported threshold to overcome the learning curve in cardiac interventions is approximately 30 to 50 cases (24).

The longer fluoroscopy time of transradial hepatic radioembolization was associated with increased radiation dose to the patients. Our study showed an average of approximately 300 mGy higher radiation dose during the radial access procedure, which is almost 100% higher compared to femoral access. The radiation dose increase is statistically significant, but the carcinogenic risk of this increased radiation to the patient is unclear. In 2006 the Biological Effects of Ionizing Radiation (BEIR) VII report endorsed a linear no-threshold (LNT) model for low dose radiation. Based on the LNT model, the risk of cancer from radiation exposure is linear regardless of the dose, without a threshold. To endorse the LNT model, the BEIR VII committee relied on the atomic bomb survivor data and radiation worker studies. However, during the recent years, these two sources of evidence have undergone important changes and no longer support the LNT hypothesis (25, 26). In addition, recent retrospective studies emphasize that correlation between CT exposure and cancer incidence may not mean causation (27, 28). Therefore, based on the most recent evidence, the increased radiation dose during the radial access procedure may not cause any harm to the patients. On the other hand, a true undebated risk of radiation exposure for the interventional radiologist is the development of cataracts (29). The lens of the eye is one of the most radiosensitive tissues in the body, and radiation doses to eye lenses may exceed the threshold for deterministic effects after several years of work in the interventional procedure suit (30).

Our preference was to access the left radial artery for hepatic radioembolization for two reasons. First, there is a decreased theoretical risk of cerebrovascular embolization during left radial access because the catheter crosses the orifice of only one cerebral vessel: the left vertebral artery. To date there is no literature supporting this theory (31). Second, during left radial access procedures the left arm is abducted approximately 80–90 degrees and the interventional radiologist is standing at approximately 1.5 times as much of a distance from the patient's mid abdomen, where the image intensifier is centered during most of the procedure. Since the radiation intensity is inversely proportional to the square of the distance from the source, the radiation exposure to the interventional radiologist is reduced during procedure from left radial access compared with femoral access. Considering the 100% increased radiation dose to the patient and the 1.5 times increased distance from the radiation source, we estimate that the radiation exposure to the operating physician is 10% less during hepatic radioembolization procedure performed from the left radial access compared with femoral access. In addition, the monitor is positioned perpendicular to the procedure table and cranial to the patient's abducted left arm and the interventional radiologist facing away from the patient, who is the major source of scattered radiation for the physician, which further decreases the radiation exposure to the lens of the eye during the procedure. However, we should note that these data are based only on hypothetical calculations because radiation exposure of the physician was not directly measured in this study. When the procedure was done via right radial access the patient's right arm was kept next to his/her body and the operating physician was in the same position as during a femoral access procedure. Therefore, the radiation exposure of the physician likely similarly increased as the patient's exposure.

In this study, we analyzed radial access for hepatic radioembolization, but radial access can be used for other interventional procedures in the systemic circulation. Radial access is ideal for morbidly obese patients (32), patients with severe peripheral artery disease and/or history of iliofemoral bypass grafting. Transradial access also should be the primary choice in patients who are on uninterrupted anticoagulation with warfarin (33) or patients with thrombocytopenia. We have performed four splenic artery embolizations from radial access in patients with platelet count of less than 50,000/μL, and there was no access site complication, despite a platelet count of 8,000/μL in one patient.

There are technical limitations to the radial access. In general, the largest recommended vascular sheath that can be used via the radial artery is 6F and this limit may be extended up to 8F (34). Therefore, procedures requiring larger vascular access sheaths may not be possible via radial access. As mentioned earlier, radial access procedures require longer catheters, which reduce pushability and torqueability of the catheters leading to increased procedure time and radiation dose. The other drawback of radial access is the difficulty to perform cone beam CT. In addition, only a very limited number of catheters, which are suitable for procedures in the systemic circulation from radial access, are commercially available. The biomedical companies need to expand their catheter repertoires with catheters long enough to reach the target abdominal, pelvic and lower extremity vascular beds for transradial interventions.

The main limitation of this study is its retrospective nature, and we report a single institution's experience. The study also lacks follow-up Doppler ultrasound evaluation of the accessed radial artery to definitively detect radial artery patency; although, all patients had palpable radial pulse at one-month follow-up and no signs of hand ischemia.

In conclusion, radial artery access is feasible for transarterial hepatic radioembolization. The transradial approach offers improved patient comfort, but it is technically more challenging, leading to longer fluoroscopy time and higher radiation dose to the patient. Radial artery access has several advantages over femoral access, and it should be considered as a primary choice in certain situations, like in low platelet count and/or morbidly obese patients. Therefore, transradial access should be in the procedural repertoire of every interventional radiologist.

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Conflict of interest disclosure

The authors declared no conflicts of interest.

References

1. Sangro B, Salem R, Kennedy A, Coldwell D, Wasan H. Radioembolization for hepatocellular carcinoma: a review of the evidence and treatment recommendations. Am J Clin Oncol 2011; 34:422–431. [CrossRef]
2. Mouli S, Memon K, Baker T, et al. Yttrium-90 radioembolization for intrahepatic cholangiocarcinoma: safety, response, and survival analysis. J Vasc Interv Radiol 2013; 24:1227–1234. [CrossRef]
3. Sato KT, Lewandowski RJ, Mulcahy MF, et al. Unresectable chemorefractory liver metastases: radioembolization with 90Y microspheres--safety, efficacy, and survival. Radiology 2008; 247:507–515. [CrossRef]
4. Feldman DN, Swaminathan RV, Kaltenbach LA, et al. Adoption of radial access and comparison of outcomes to femoral access in percutaneous coronary intervention: an updated report from the national cardiovascular data registry (2007–2012). Circulation 2013; 127:2295–2306. [CrossRef]
5. Valgimigli M, Gagnor A, Calabro P, et al. Radial versus femoral access in patients with acute coronary syndromes undergoing invasive management: a randomised multicentre trial. Lancet 2015; 385:2465–2476. [CrossRef]
6. Agostoni P, Biondi-Zoccai GG, de Benedictis ML, et al. Radial versus femoral approach for percutaneous coronary diagnostic and interventional procedures; Systematic overview and meta-analysis of randomized trials. J Am Coll Cardiol 2004; 44:349–356. [CrossRef]
7. Joyal D, Bertrand OF, Rinfret S, Shimony A, Eisenberg MJ. Meta-analysis of ten trials on the effectiveness of the radial versus the femoral approach in primary percutaneous coronary intervention. Am J Cardiol 2012; 109:813–818. [CrossRef]
8. 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; 138:430–436. [CrossRef]
9. Sciahbasi A, Fischetti D, Picciolo A, et al. Transradial access compared with femoral puncture closure devices in percutaneous coronary procedures. Int J Cardiol 2009; 137:199–205. [CrossRef]
10. Mercuri M, Mehta S, Xie C, Valettas N, Velianou JL, Natarajan MK. Radial artery access as a predictor of increased radiation exposure during a diagnostic cardiac catheterization procedure. JACC Cardiovasc Interv 2011; 4:347–352. [CrossRef]
11. Kayashima Y, Satou T, Ito K. Usefulness of transradial angiography and interventional angiography for abdominal diseases: comparison with transfemoral or transbrachial approach. Nihon Igaku Hoshasen Gakkai Zasshi 2001; 61:25–28.
12. Patel T, Shah S, Pancholy S, et al. Utility of transradial approach for peripheral vascular interventions. J Invasive Cardiol 2015; 27:277–282.
13. 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; 25:443–447. [CrossRef]
14. Ruzsa Z, Toth K, Jambrik Z, et al. Transradial access for renal artery intervention. Interv Med Appl Sci 2014; 6:97–103. [CrossRef]
15. 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; 37:412–417. [CrossRef]
16. Matsumoto Y, Hokama M, Nagashima H, et al. Transradial approach for selective cerebral angiography: technical note. Neurol Res 2000; 22:605–608.
17. Pinter L, Cagiannos C, Ruzsa Z, Bakoyiannis C, Kolvenbach R. Report on initial experience with transradial access for carotid artery stenting. J Vasc Surg 2007; 45:1136–1141. [CrossRef]
18. Aminian A, Dolatabadi D, Lefebvre P, et al. Initial experience with the Glidesheath Slender for transradial coronary angiography and intervention: a feasibility study with prospective radial ultrasound follow-up. Catheter Cardiovasc Interv 2014; 84:436–442. [CrossRef]
19. Mitchell MD, Hong JA, Lee BY, Umscheid CA, Bartsch SM, Don CW. Systematic review and cost-benefit analysis of radial artery access for coronary angiography and intervention. Circ Cardiovasc Qual Outcomes 2012; 5:454–462. [CrossRef]
20. Rao SV, Kedev S. Approaching the post-femoral era for coronary angiography and intervention. JACC Cardiovasc Interv 2015; 8:524–526. [CrossRef]
21. Cowling MG, Buckenham TM, Belli AM. The role of transradial diagnostic angiography. Cardiovasc Intervent Radiol 1997; 20:103–106. [CrossRef]
22. Naritaka Y, Shiozawa S, Shimakawa T, et al. Transradial approach for partial splenic embolization in patients with hypersplenism. Hepatogastroenterology 2007; 54:1850–1853.
23. 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. [CrossRef]
24. Hess CN, Peterson ED, Neely ML, et al. The learning curve for transradial percutaneous coronary intervention among operators in the United States: a study from the National Cardiovascular Data Registry. Circulation 2014; 129:2277–2286. [CrossRef]
25. Ozasa K, Shimizu Y, Suyama A, et al. Studies of the mortality of atomic bomb survivors, Report 14, 1950–2003: an overview of cancer and noncancer diseases. Radiat Res 2012; 177:229–243. [CrossRef]
26. Zablotska LB, Lane RS, Thompson PA. A reanalysis of cancer mortality in Canadian nuclear workers (1956–1994) based on revised exposure and cohort data. Br J Cancer 2014; 110:214–223. [CrossRef]
27. Huang WY, Muo, CH, Lin CY, et al. Paediatric head CT scan and subsequent risk of malignancy and benign brain tumour: a nation-wide population-based cohort study. Br J Cancer 2014; 110:2354–2360. [CrossRef]
28. Journy N, Rehel JL, Ducou Le Pointe H, et al. Are the studies on cancer risk from CT scans biased by indication? Elements of answer from a large-scale cohort study in France. Br J Cancer 2015; 112:185–193. [CrossRef]
29. Vano E, Kleiman NJ, Duran A, Romano-Miller M, Rehani MM. Radiation-associated lens opacities in catheterization personnel: results of a survey and direct assessments. J Vasc Interv Radiol 2013; 24:197–204. [CrossRef]
30. Vano E, Gonzalez L, Fernandez JM Haskal ZJ. Eye lens exposure to radiation in interventional suites: caution is warranted. Radiology 2008; 248:945–953. [CrossRef]
31. Pacchioni A, Versaci F, Mugnolo A, et al. Risk of brain injury during diagnostic coronary angiography: comparison between right and left radial approach. Int J Cardiol 2013; 167:3021–3026. [CrossRef]
32. Hibbert B, Simard T, Wilson KR, et al. Transradial versus transfemoral artery approach for coronary angiography and percutaneous coronary intervention in the extremely obese. JACC Cardiovasc Interv 2012; 5:819–826. [CrossRef]
33. Baker NC, O'Connell EW, Htun WW, et al. Safety of coronary angiography and percutaneous coronary intervention via the radial versus femoral route in patients on uninterrupted oral anticoagulation with warfarin. Am Heart J 2014; 168:537–544. [CrossRef]
34. Wu SS, Galani RJ, Bahro A, Moore JA, Burket MW, Cooper CJ. 8 french transradial coronary interventions: clinical outcome and late effects on the radial artery and hand function. J Invasive Cardiol 2000; 12:605–609.