Original Article

Feasibility and safety of transarterial chemoembolization in patients with liver cancer via the distal radial approach: a single-center retrospective cohort study

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Background: The femoral artery is the standard route for transarterial chemoembolization (TACE); however, it is negatively associated with the quality of life of patients, and carries an increased risk of deep vein thrombosis in the lower limbs. We employed the distal radial approach to TACE to assess its feasibility and safety.

Methods: We conducted a retrospective study at the First Hospital of Jilin University from August 1, 2020 to October 31, 2023. To be eligible for inclusion in the study, the patients had to meet the following main inclusion criteria: (I) have undergone a preoperative imaging (abdominal computed tomography enhancement or magnetic resonance dynamic enhancement) examination, or have a pathologically confirmed diagnosis of primary liver cancer, and a Child-Pugh score of A or B; and (II) have undergone distal radial artery puncture. The primary endpoint of this study was the success rate of distal radial artery puncture. The secondary endpoints were complications and the duration of the puncture.

Results: Among the 343 patients with primary liver cancer (of whom 236 were male and 107 were female), a total of 1,315 distal radial artery punctures were attempted. The success rate was remarkably high at 95.13% (1,251/1,315), with only 64 cases requiring an alternative approach due to failed puncture. The average puncture duration was 20±7.43 minutes. No bleeding and hematoma, no arterial dissection and pseudoaneurysm formation were observed on ultrasound, and the radial pulse was palpable in all patients, highlighting the safety of the procedure. Further, no adverse events of vascular occlusion were observed among the 12 patients who received 6 or more punctures, indicating the sustainability of the distal radial artery access under the premise of adequate vascular protection. The development of this technique requires a learning curve of at least 50 cases to break through the learning baseline and be proficient in distal radial artery blind puncture. This may be the reason why many interventional physicians are reluctant to perform this procedure, adapting to the femoral approach with a shorter learning curve.

Conclusions: The distal radial artery approach is feasible and safe in hepatic arterial chemoembolization, and should be widely promoted in TACE.

Keywords: Primary liver cancer; distal radial artery; puncture; transarterial chemoembolization (TACE)

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Introduction

Transarterial chemoembolization (TACE) is the preferred treatment for intermediate and advanced primary liver cancer (1-3). The standard route involves puncturing the transfemoral artery. The large size of the femoral artery allows for multiple TACE procedures, making it ideal for various endovascular treatments. TACE through the transfemoral artery provides an effective and efficient approach for managing intermediate and advanced liver cancers.

After undergoing the traditional TACE procedure, patients often find themselves confined to bed and limited in their activities. This strict bed rest not only affects their quality of life but also hinders their compliance with treatment. The extended compression time at the puncture site leads to discomfort in eating and using the restroom, as well as an increased risk of deep vein thrombosis in the lower limbs. Patients may also experience bleeding at the puncture site, and are at risk of complications such as pseudoaneurysm formation. However, with advancements in puncture techniques, the transdistal radial approach has emerged as a promising alternative (4-7). However, no peripheral interventional physicians have reported the results of TACE treatment via the distal radial approach. The development of this technique requires a learning curve of at least 50 cases to break through the learning baseline and be proficient in distal radial artery blind puncture. This may be the reason why many interventional physicians are reluctant to perform this procedure, adapting to the femoral approach with a shorter learning curve. By using the distal radial approach, which accesses the radial artery through the snuffbox area, patients can benefit from a more comfortable and less restrictive procedure. This technique targets a triangular depression enclosed by specific tendons and bone structures, offering a safer and more efficient alternative for patients undergoing TACE.

This study investigated the feasibility and safety of hepatic arterial chemoembolization using TACE treatment via the distal radial approach in the upper extremity. It aimed to explore the effectiveness of this innovative approach. Our findings demonstrate the potential benefits of this method in improving patient outcomes while ensuring safety during the procedure. We present this article in accordance with the STROBE reporting checklist (available at https://tcr.amegroups.com/article/view/10.21037/tcr-24-1231/rc).

Highlight box

Key findings

- The distal radial approach has a high success rate of puncture after reaching the learning curve, with better patient comfort and fewer complications.

What is known, and what is new?

- Under the standard approach, transarterial chemoembolization (TACE) is performed via the femoral artery, but this approach affects the quality of life of patients, and increases the risk of deep vein thrombosis in the lower extremities.
- The distal radial artery puncture approach has a high puncture success rate and a favorable safety profile.

What is the implication, and what should change now?

- Clinicians should consider increasing the use of distal radial artery puncture in TACE in their clinical practice.

Methods

This study was conducted at the First Hospital of Jilin University from August 1, 2020, to October 31, 2023 to investigate the success rate of distal radial artery puncture in patients with primary liver cancer. To be eligible for inclusion in this study, the patients had to meet the following inclusion criteria: (I) have pathological confirmation of primary liver cancer through imaging; (II) have a Child-Pugh score of A or B; (III) have a negative Allen test result, indicating an ability to accurately palpate the pulse of the distal radial artery; and (IV) provide or have a family member provide informed consent. Patients were excluded from the study if they met any of the following exclusion criteria: (I) had inaccessible distal radial pulses; (II) had a history of radial arteriotomy dialysis; and/or (III) had undergone a preoperative radial artery ultrasound that showed a tortuous angle that hindered guidewire catheter passage. The primary endpoint of our study was to determine the success rate of distal radial artery puncture, providing valuable insights for medical practitioners and researchers in the field.

Under the TACE procedure, the patient is placed in a supine position on the Digital Subtraction Angiography table with either the left or right palm placed flat on the middle and lower abdomen. Once local anesthesia with 0.5–1 mL of 2% lidocaine has been administered to the area of the distal radial artery, a 21-G needle is used to puncture the artery. As blood begins to spurt out, a short guidewire (0.018 in) is inserted. The needle is then removed, and a 5 F- or 4 F-micropuncture sheath is inserted (as shown

Figure 1 Puncturing the distal radial artery for catheter sheath insertion. After successfully puncturing the distal radial artery, the patient is positioned supine with their hands placed on the abdomen. The catheter sheath remains in place, ensuring continuous access for necessary medical procedures.

Figure 2 Effective methods for preventing postoperative bleeding. Following the operation, a tight elastic bandage was applied to the radial artery puncture site to control bleeding for 3 hours. This compression method effectively stopped the blood flow and promoted proper healing.

in *Figure 1*), after which the dilator and guidewire are removed. The sheath is flushed with a slow rinse of 200 μg of nitroglycerin, followed by a rinse of lidocaine, and finally a rinse with 3,000 units of heparin sodium injection. With the successful establishment of the distal radial artery approach, a 125-cm MPA1/Ultimate 1 catheter and a 180-cm 0.035-in guidewire are guided into the upper limb artery on either the left or right side. The catheter is then directed through the brachial artery, axillary artery, and subclavian artery into the aorta. Once in the aorta, the catheter is used to search for potential tumor supply arteries, such as the hepatic artery, superior mesenteric artery (SMA), or phrenic artery. Following successful selection, the SMA is carefully navigated, the guidewire is withdrawn, contrast is injected using a high-pressure syringe, and a 150-cm microcatheter is used to precisely target the tumor blood supply for chemoembolization. After the procedure, the puncture sheath is removed, and the puncture site is bandaged with an elastic bandage to prevent bleeding (as shown in *Figure 2*). Compression is maintained for a period of 3 hours post-procedure.

This study sought to evaluate the success of using the distal radial artery as an access point for TACE. The primary goal was to determine the effectiveness of puncturing the distal radial artery and successfully completing the chemoembolization procedure through this pathway. In this study, instances in which the distal radial artery could not be punctured, or was punctured successfully but chemoembolization could not be completed were considered failures. The secondary endpoints included monitoring for complications, such as bleeding, hematoma, arterial dissection, pseudoaneurysm formation, and distal radial artery occlusion within 3 days of the procedure. Puncture duration was also assessed as a secondary endpoint. To ensure the quality of the study, two professors from the department supervised and oversaw the quality control processes, reducing the effect of operator experience and subjective biases. The study adhered to the Declaration of Helsinki (as revised in 2013) and was approved by the First Hospital of Jilin University [Provisional Examination No. (2023-630)]. Informed consent was obtained from all the participants involved in the study.

Statistical analysis

The categorical variables are statistically described as the frequency and proportion, and the continuous variables are statistically described as the median [interquartile range (IQR)] or mean [standard deviation (SD)]. The 95% confidence intervals of the categorical variables were estimated using the Clopper-Pearson method. All the statistical analyses were performed using SPSS Statistics software version 26 (IBM Corp., Armonk, NY, USA).

Table 1 Clinical characteristics of patients (N=343)

Characteristic	Value
Age, years, mean ± SD	59.4±3.5
Gender, n	
Male	236
Female	107
Clinical stage, n	
I	6
II	128
III	204
IV	5
Tumor diameter, n	
<3 cm	9
3–5 cm	24
>5–10 cm	296
>10 cm	14
Hepatitis, n	
HBV	265
HCV	33
None	45
Grading of liver function, n	
Child-Pugh A	122
Child-Pugh B	221

SD, standard deviation; HBV, hepatitis B virus; HCV, hepatitis C virus.

Results

The study included 343 patients, of whom 236 were men and 107 were women, and excluded 39 patients for various reasons (23 due to an inability to palpate distal radial pulse, 12 due to radial artery dialysis, 3 due to the tortuous angles on the preoperative ultrasound, and 4 due to difficulties related to the guidewire passage). The clinical characteristics of the enrolled patients are set out in *Table 1*. A total of 1,315 distal radial artery punctures were carried out, all with 21-G steel needles and 5 F/4 F sheaths. This study highlighted the challenges that arose in conducting procedures on patients with certain radial artery conditions, and thus shed light on the complexities involved in ensuring successful outcomes in such cases.

The puncture success rate was high at 95.13% in this study of 1,315 cases. In the 64 instances of failure, radial or femoral artery approaches were used. The cases of puncture failure were all in the early stage of the study, which was the stage when the team broke through the learning curve, and the success rate of puncture was very high after breaking through the bottleneck of the learning curve. Specifically, the radial artery approach was used in 57 cases, and the femoral artery approach was used in 7 cases. The average puncture time was 20±7.43 minutes, demonstrating the efficiency and effectiveness of the procedures used in the study.

The MPA1 catheter had a success rate of 98.28% (859 of 874) with all cases being successful following the exchange of a 5-F pigtail catheter. Similarly, the Ultimate 1 catheter had a 100% success rate (377 of 377) in selecting the descending aorta. The Ultimate 1 catheter is more curved and easily accessed through the subclavian artery; however, it is a 4-F catheter, and it is slightly less maneuverable than the MPA1 catheter for longer strokes. Despite this, both catheter options achieved a 100% success rate in accessing arteries supplying the tumor. These findings underscore the reliability and efficacy of these catheters in vascular procedures.

In this study, which included 12 patients who underwent 6 or more distal radial artery punctures, no complications, such as bleeding, hematoma, arterial dissection, pseudoaneurysm formation, or distal radial artery occlusion, were observed. Additionally, no adverse events of vascular occlusion were reported. Within 3 days of completing the embolization, both the distal radial artery and radial artery pulsed well with no delayed hematoma or hemorrhage at the puncture site. A summary of the patient outcomes can be found in *Table 2*. This study showed the safety and effectiveness of multiple distal radial artery punctures in medical procedures.

Discussion

In 2011, Babunashvili and Dundua (8) introduced a novel technique for accessing the radial artery through the distal approach, marking a significant advancement in interventional procedures. This innovative method allowed for proximal radial artery occlusion to be effectively treated by entering through the snuff socket in a retrograde transdistal manner. Building on this breakthrough, Kiemeneij (9) further developed the distal radial artery puncture technique in 2017, primarily for cardiac coronary interventions. This approach offers a clear bony structure

Table 2 Short form of patients outcomes

Items to observe	Value
Puncture success	1,251/1,315 (95.13%)
Puncture failure	64/1,315 (4.87%)
Changed to the radial artery	57
Changed to the femoral artery	7
Success rate of selection of descending aorta	1,251
MPA1	859/874 (98.28%)
Ultimate 1	377/377 (100%)
Bleeding or hematoma	0
Arterial dissection	0
Pseudoaneurysm formation	0
Distal radial artery occlusion	0
Puncture time, minutes, mean ± SD	20±7.43
Delayed hematoma or hemorrhage	0

SD, standard deviation.

for precise puncture site localization and effective hemostasis through compression. These advancements have revolutionized interventional procedures, providing safer and more efficient treatment options for patients worldwide.

The use of the femoral artery approach in patients undergoing TACE requires stringent bed rest and results in limited mobility, which significantly affects patients' quality of life and treatment adherence. The extended compression time at the puncture site hinders patients' ability to perform daily activities, such as eating and using the restroom, and raises the risk of deep vein thrombosis in the lower limbs, puncture site bleeding, and formation of pseudoaneurysms. Attempts have been made to use a transradial approach for TACE; however, the outcome has been unsatisfactory due to the high incidence of postoperative radial artery occlusion. A previous study has reported occlusion rates ranging from 0–33% (10); however, these low rates might have been due to inadequate heparinization during the procedure. This jeopardizes the feasibility of conducting TACE using the radial artery approach in the future. Further research is needed to address these challenges and improve the efficacy and safety of this minimally invasive treatment option.

At our center, a total of 1,315 distal radial artery punctures were performed, with 12 patients undergoing 6 or more punctures. The majority of patients underwent 2 or more punctures without experiencing any issues, such as occlusion or complications to the hand. The primary reasons for distal radial artery puncture failure were related to the slenderness of the blood vessels, and spasm after puncture. However, such failures can be overcome by transitioning to the radial or femoral artery puncture method. No significant discrepancy in the total time for the interventional procedures was observed between the distal radial artery approach and the femoral artery approach. This suggests that the choice of approach does not significantly affect the overall operation time.

Differences in the timing of the cannulation of blood supply arteries for liver cancer have been observed using the upper and inferior approaches. Comparisons of celiac trunk cannulation through the distal radial artery (the upper approach) and transfemoral artery (the inferior approach) have shown that the upper approach is generally easier and quicker. However, the proficiency of the operator in each approach can influence the overall cannulation time. Similar findings have been observed in comparisons of the cannulation of the SMA. Despite any challenges encountered, such as intubating tumor blood supply arteries from mutated blood supply arteries like the right renal artery and phrenic artery, it is possible to navigate these pathways successfully. In cases in which celiac trunk occlusion is present, additional considerations must be taken into account. Factors such as abnormal vascular communication, tortuosity, and the lengthening of the blood vessels supplying the right artery omental branches can pose challenges. Limitations in catheter length, such as those with the MPA1/Ultimate l catheter, may also need to be addressed. In these instances, options such as cutting the tail of the support catheter short can help address these issues.

Studies have reported that the occurrence of complications, such as distal radial artery occlusion, hematoma, radial artery dissection, arteriovenous fistula, and pseudoaneurysm, during radial artery catheterization, range from 0.0% to 5.2% (11-13). However, at our medical center, the incidence of distal radial artery occlusion was 0%, with no cases of wrist hematoma, radial artery dissection, or aneurysm reported. This impressive outcome could be related to our meticulous approach, which includes the administration of nitroglycerin during anesthesia, the careful insertion and management of catheter sheaths, and the use of heparin. These strategies have proven to be effective in reducing the occurrence of complications

associated with radial artery catheterization, ensuring a safer and more successful procedure for patients.

Continuing long-term observational follow up is crucial to accurately summarize distal radial artery complications and improve patient outcomes.

As this was a single-center study, the stability of the results might have been affected. It is crucial that multi-center, large-sample comparative studies with our peers be conducted in the future to enhance the research validity and reliability of these findings. Collaborations can strengthen findings and broaden the scope of a study's impact.

Conclusions

TACE for primary liver cancer using the distal radial artery approach has been shown to be a secure and viable option. When there are no contraindications, this method can effectively replace traditional access via the femoral artery, enhancing safety and decreasing risks. In the future, TACE procedures may be able to be conducted in outpatient settings or as day surgeries. This could alleviate the strain placed on hospitals, lessen the financial burden placed on patients, and alleviate the pressure placed on medical insurance providers. Ultimately, this transition could improve the efficiency of health care overall.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://tcr.amegroups.com/article/view/10.21037/tcr-24-1231/rc

Data Sharing Statement: Available at https://tcr.amegroups.com/article/view/10.21037/tcr-24-1231/dss

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Ethical Statement: The authors are accountable for all aspects of the work, including ensuring that any questions related to the accuracy or integrity of any part of the work have been appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the First Hospital of Jilin University [Provisional Examination No. (2023-630)], and informed consent was obtained from all the individual participants.

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