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Original Article

Comparative study of the clinical value of digital subtraction angiography via femoral and radial arterial paths

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Abstract: Objective: To evaluate the clinical efficacy of digital subtraction angiography (DSA) performed via femoral artery and radial artery approaches. Methods: This retrospective study included 480 patients requiring cerebral vascular angiography at the First People's Hospital of Changde City from March 2020 to February 2022. Patients were divided into the femoral artery group (transfemoral approach, n=400) and the radial artery group (transradial approach, n=80) according to the surgical route. We compared perioperative metrics, success rates of selective angiography and puncture, and complication rates (including pseudoaneurysm, urinary retention, hematoma, vasospasm) between the groups. Multivariate logistic regression was used to analyze factors influencing the failure of angiography by each approach. Results: The radial artery group exhibited shorter durations for puncture, hemostasis, exposure, operation, and postoperative recovery (all P<0.001). The success rate of selective angiography was higher in the radial artery group (93.75%) compared to the femoral artery group (85.25%) (χ^2=4.168, P=0.041). No significant difference was found in puncture success rates between the groups (χ^2=0.235, P=0.628). The overall complication rate was significantly lower in the radial artery group (2.50%) compared to the femoral artery group (9.25%) (χ^2=4.069, P=0.044). Gender and low-density lipoprotein cholesterol levels were significant predictors of angiography failure in both approaches (both P<0.05). Conclusion: The transradial approach for DSA is safe and feasible, offering advantages in terms of operational time and complication rates, making it the preferred method in clinical settings.

Keywords: Digital subtraction angiography, femoral artery, radial artery

Introduction

Digital subtraction angiography (DSA) is a pivotal tool for diagnosing cerebrovascular diseases, offering clear imaging with a minimal contrast agent requirement, thereby establishing it as the clinical "gold standard" [1]. Currently, the femoral artery approach and the radial artery approach are the two primary surgical methods for DSA. The femoral artery approach involves placing arterial sheaths post-puncture of the right femoral artery to facilitate selective arteriography guided by wires [2]. This approach benefits from the artery's substantial size and straightforward access, ensuring high puncture success rates and ease of interventional procedures [3, 4]. However, the deep anatomical placement of the femoral artery complicates postoperative hemostasis, potentially leading to severe hemorrhage, subcutaneous hematoma, and false aneurysms. Excessive pressure at the site can induce vagal reflexes, bradycardia, and hypotension. Mandatory bed rest post-operation (12-24 hours) may cause back pain, urinary discomfort, lung infections, and lower limb venous thrombosis [5-8].

In contrast, the radial artery approach, predominant in cardiac interventions and the preferred method for coronary angiography, has been less explored in cerebrovascular interventions [9, 10]. This method alleviates the need for prolonged bed rest and reduces bleeding complications. Nonetheless, it is not devoid of disadvantages, such as potential artery spasm or

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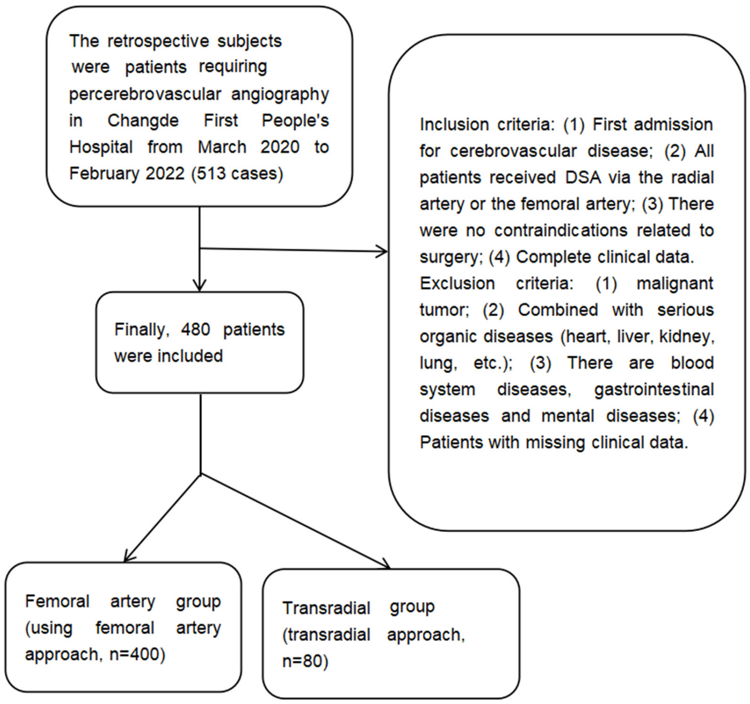

Figure 1. Study flowchart. DSA, digital subtraction angiography.

occlusion post-multiple punctures and hematoma due to improper compression.

Despite the growing utilization of both approaches, comparative clinical studies remain scarce. This study retrospectively analyzes and compares the safety and feasibility of the femoral and radial artery approaches for DSA, aiming to provide a comprehensive evaluation of their clinical value.

Materials and methods

Participant information

This retrospective study analyzed 513 patients who required cerebrovascular angiography at Changde First People's Hospital from March 2020 to February 2022.

Inclusion criteria: (1) First hospital admission for cerebrovascular disease. (2) Underwent DSA via either the radial artery or the femoral artery. (3) No contraindications related to the surgical procedure. (4) Availability of complete clinical data.

Exclusion criteria: (1) Presence of malignant tumors. (2) Comorbidity with severe organic diseases (including cardiovascular, hepatic, renal, or pulmonary conditions). (3) Blood system disorders, gastrointestinal diseases, or mental health disorders. (4) Incomplete clinical data.

After applying these criteria, 480 patients remained eligible for inclusion in the study. Patients were assigned to either the femoral group (transfemoral approach, n=400) and transradial group (transradial approach, n=80) according to the surgical route (**Figure 1**). The study received approval from the Ethics Committee of Changde First People's Hospital.

Methods

For the femoral artery group, the procedure began with the patient in a supine position. Local infiltration anesthesia was achieved using 5 mL of 1% lidocaine. The puncture site was selected 1.5 to 3.0 cm below the inguinal ligament at the point of strongest femoral artery pulsation. The Seldinger technique was employed to perform the puncture, maintaining an angle of 30 to 45 degrees. Following a successful puncture, a J-shaped short guide wire was inserted through a 5F femoral artery sheath tube. After the guide wire's removal, 3000 U of heparin was administered intravenously, and arteriography was performed using a 5F pigtail catheter for aortography and a 5F single lumen catheter for bilateral common carotid and vertebral artery angiography. Hemostasis was achieved with an elastic bandage and sandbag compression for 6 hours, with the affected limb immobilized post-procedure. The bandage was removed after 24 hours.

For the radial artery group, the procedure also started with the patient in a supine position and local infiltration anesthesia using 5 mL of 1% lidocaine. The puncture site was selected at the point of strongest radial artery pulsation, using a specialized radial artery puncture kit and the Seldinger technique. After arterial blood spray confirmed a successful puncture, an arterial sheath was inserted, followed by the administration of 200 μg nitroglycerin through the sheath and 3000 U heparin intravenously. Arterial angiography was conducted using a 5F pigtail catheter for aortic arch angiography and SimmonI and SimmonII catheter loops for bilateral carotid and vertebral artery angiography. After forming aortic arch loops, the catheter was retracted to complete selective angiography. The procedure concluded with the removal of the sheath and application of a specialized radial artery hemostat for 6 hours to achieve hemostasis [10].

Outcome measures

Data on perioperative outcomes, selective arteriography success, puncture success, and postoperative complications were collected for both groups. Additionally, factors influencing DSA failure were explored.

Perioperative outcomes: These included contrast agent dosage, puncture time, hemostatic time, exposure time, operation time, and postoperative recovery time.

Selective angiography and puncture success rates: Success rates for both procedures were analyzed across the groups.

Incidence of complications: Complications such as pseudoaneurysm, urinary retention, hematoma, and vasospasm were evaluated.

Factors affecting angiography failure: Analysis was conducted to determine the factors impacting the failure of cerebrovascular angiography for both approaches.

Statistical methods

Data were entered into Excel 2007 and analyzed using SPSS 25.0. Continuous variables were tested for normality and described using mean ± standard deviation, and compared using independent sample t-tests. Categorical data were expressed as percentages and analyzed with the chi-square test. Multivariate logistic regression was utilized to identify factors affecting the failure of cerebral angiography. A significance level (α) of 0.05 was set, with P<0.05 indicating statistical significance.

Results

Comparison of baseline data

No significant differences were found between the two groups (P>0.05) as shown in **Table 1**.

Comparison of perioperative indexes

There were no significant differences in contrast agent dosage between groups (P>0.05). The radial artery group had significantly shorter times for puncture, hemostasis, exposure, operation, and postoperative recovery (all P<0.05), as detailed in **Table 2**.

Comparison of success rate of selective angiography

The radial artery group had a higher success rate of 93.75% (75/80) compared to 85.25% (341/400) in the femoral artery group (χ^2=4.168, P=0.041), as depicted in **Figure 2**.

Comparison of puncture success rate

The puncture success rate was 96.25% (77/80) in the radial artery group and 97.25% (389/400) in the femoral artery group, with no significant difference, shown in **Figure 3**.

Comparison of complications

Complications in the radial artery group were significantly lower at 2.5% compared to 9.25% in the femoral artery group (χ^2=4.069, P=0.044), as detailed in **Table 3**.

Analysis of influencing factors for EDSA failure occurred in 64 out of 480 patients. Independent variables included gender (male =1, female =0), hypertension (yes =1, no =0), diabetes (yes =1, no =0), and surgical approach (femoral artery =1, radial artery =0). Univariate and multivariate analyses identified hypertension, diabetes, low-density lipoprotein cholesterol (LDL-C) levels, puncture time, and surgical approach as significant factors influencing DSA failure, with gender emerging as a protective factor (P<0.05), as indicated in **Table 4**.

Discussion

Imaging techniques for diagnosing cerebrovascular diseases range from non-invasive methods like ultrasound and CT angiography, which

Table 1. Comparison of general data

Group	Gender (male/female)	Age	BMI (kg/m^2)	Hypertension (Yes/No)	Diabetes (Yes/No)	Fasting blood glucose (mmol/L)	TC (mmol/L)	LDL-C (mmol/L)	Homocysteine (μmol/L)
Radial artery group (n=80)	55/25	54.09±14.88	24.34±2.58	30/50	21/59	4.88±1.37	4.57±1.57	2.13±0.55	11.72±3.92
Femoral artery group (n=400)	238/162	56.20±14.62	24.30±2.82	109/291	88/312	4.83±1.20	4.60±1.42	2.09±0.53	11.73±3.73
χ^2/t	2.399	-1.174	0.074	3.405	0.686	0.331	-0.181	0.608	0.006
P	0.121	0.241	0.941	0.065	0.408	0.741	0.856	0.543	0.995

BMI, body mass index; LDL-C, low-density lipoprotein cholesterol; TC, total cholesterol.

Table 2. Comparison of perioperative indexes

Group	Amount of contrast agent (mL)	Puncture time (min)	Hemostasis time (min)	Exposure time (min)	Operation time (min)	Postoperative recovery time (h)
Radial artery group (n=80)	59.59±11.58	3.09±0.86	1.40±0.43	4.80±0.56	29.73±6.35	5.54±1.47
Femoral artery group (n=400)	62.15±12.45	4.76±1.34	18.47±5.56	5.33±0.52	41.19±9.35	21.45±3.30
t	-1.701	-10.697	-27.440	-8.080	-10.493	-42.222
P	0.090	<0.001	<0.001	<0.001	<0.001	<0.001

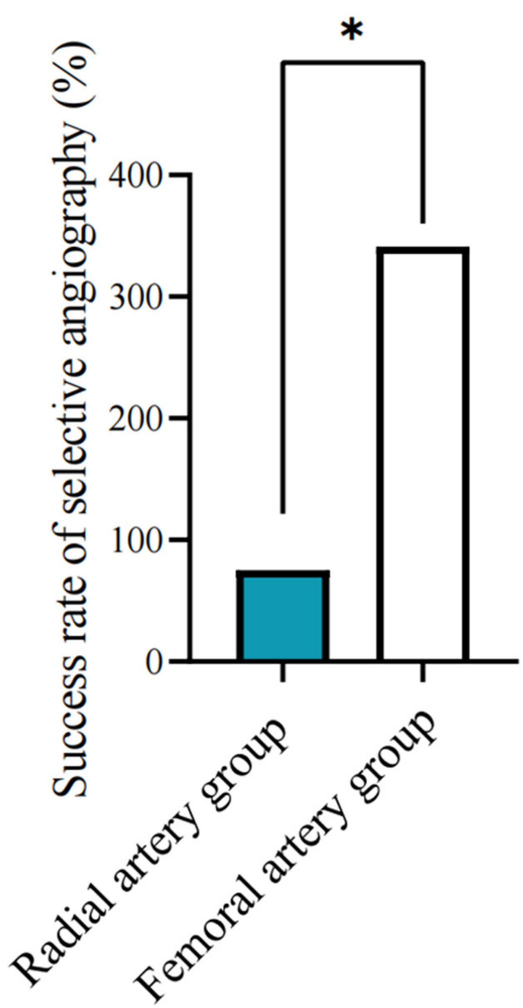

Figure 2. Comparison of the success rate of selective angiography. $^{*}P$<0.05.

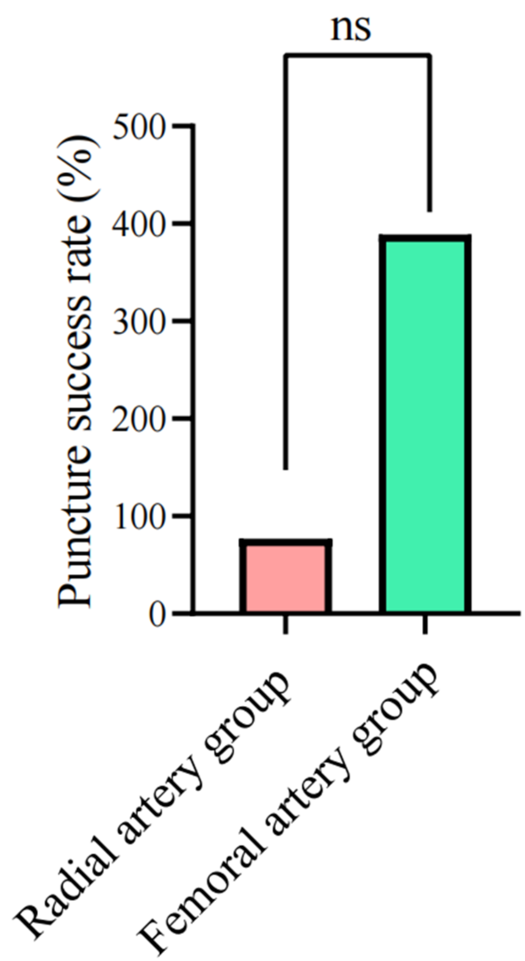

Figure 3. Comparison of puncture success rates. ^{ns}P<0.05.

have less physical trauma but suboptimal diagnostic accuracy [11], to invasive methods like DSA, which boasts nearly 100% diagnostic accuracy and plays a crucial role in the clinical diagnosis of cerebrovascular diseases [12].

Transfemoral angiography, commonly used due to the femoral artery's large diameter and ease of puncture, often leads to complications. In contrast, transradial angiography offers several advantages, such as minimal nerve injury due to the absence of large nerves and vessels around the radial artery and better hemostasis support. Despite these benefits, challenges include the radial artery's small size, making punctures more difficult and often requiring multiple attempts, which increases the risk of

Table 3. Comparison of complications

Group	Pseudoaneurysm	Urinary retention	Vasospasm	Hematoma	Total incidence
Radial artery group (n=80)	0 (0.00)	2 (2.50)	0 (0.00)	0 (0.00)	2 (2.50)
Femoral artery group (n=400)	6 (1.50)	12 (3.00)	10 (2.50)	9 (2.25)	37 (9.25)
χ^2	1.251	0.537	2.043	1.834	4.069
P	0.270	0.464	0.153	0.176	0.044

Table 4. Analysis of influencing factors of DSA failure in patients

Index	Single-factor		Multi-factor	
	HR (95% CI)	P	HR (95% CI)	P
Sex	0.402 (0.234-0.692)	0.001	0.371 (0.200-0.689)	0.002
Age	1.006 (0.988-1.024)	0.504	-	-
BMI	0.964 (0.877-1.060)	0.453	-	-
Hypertension	5.198 (2.898-9.041)	<0.001	2.157 (1.019-1.566)	0.045
Diabetes	8.382 (4.749-14.794)	<0.001	5.910 (2.777-12.574)	<0.001
Fasting blood glucose	1.077 (0.869-1.335)	0.500	-	-
TC	0.930 (0.774-1.117)	0.437	-	-
LDL-C	2.147 (1.298-3.550)	0.003	2.627 (1.477-4.672)	0.001
Homocysteine	1.007 (0.939-1.080)	0.844	-	-
Amount of contrast agent	0.988 (0.967-1.009)	0.060	-	-
Puncture time	1.350 (1.113-1.637)	0.002	1.302 (1.019-1.664)	0.035
Hemostasis time	1.022 (0.988-1.057)	0.204	-	-
Exposure time	1.107 (0.695-1.764)	0.669	-	-
Operation time	1.008 (0.982-1.035)	0.550	-	-
Surgical path	2.598 (1.007-6.687)	0.048	3.230 (1.023-10.202)	0.046

BMI, body mass index; LDL-C, low-density lipoprotein cholesterol; TC, total cholesterol.

vasospasm and demands higher skill from operators [13]. Studies by Brueck et al. [14] and Bhat et al. [15] highlight significantly lower complication rates in the radial group compared to the femoral group The pooled analysis of multiple randomized controlled trials indicated that major vascular complications, while rare, could be severe [16]. This was demonstrated in the RIVAL study, where the most common major complication was large hematoma [17].

This study identified hypertension, diabetes, LDL-C, puncture time, and surgical path as significant factors influencing DSA failure, with sex emerging as a protective factor. Hypertension may damage vascular endothelium and decrease elasticity, increasing the risk of DSA failure during procedures like transarterial catheterization and contrast injection, due to heightened vessel sensitivity to procedural stimuli [18, 19]. Diabetes disrupts glucose and lipid metabolism, which can cause abnormal blood glucose fluctuations during puncture, thereby increasing the risk of DSA failure [20, 21].

High levels of LDL-C, known to promote coronary atherosclerosis [22], thicken blood and slow circulation, exacerbating atherosclerosis and increasing the likelihood of thrombosis due to unstable lipid-laden plaques. LDL-C also impairs endothelial function, induces adhesion molecule expression, stimulates smooth muscle cell proliferation, and activates leukocytes, all contributing to thrombosis and neointimal thickening [23-25]. Extended puncture duration can damage vascular walls, raising the risk of rupture or bleeding and potentially leading to vasospasm or thrombosis, which compromises cerebral blood supply and DSA success. Clinical observations have highlighted several issues with the femoral artery approach; despite its larger size and ease of access, its deep anatomical location near the pelvic cavity, often obscured by fat, poses challenges particularly in overweight patients or those with poor circulation, increasing the risk of thrombosis, false aneurysms, and vasospasm [26-28]. The protective effect associated with female sex is speculated to be linked to estrogen or unique female physiological cycles [29].

This study still has some shortcomings. This single-center, retrospective study with a limited sample size faces inherent constraints. The short tracking period for clinical observation indicators and the absence of long-term follow-up limit the study's comprehensiveness. Additionally, varying levels of operator expertise may have influenced the results. However, with advancements in angiography techniques and interventional equipment, the efficacy of the radial artery approach is expected to improve.

The radial artery approach for DSA has proven safer and more effective, significantly reducing operative and postoperative recovery times, improving the success rate of selective arteriography, and minimizing postoperative complications. Therefore, it is recommended as the preferred method for DSA procedures.

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Disclosure of conflict of interest

None.

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