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INTERVENTIONAL RADIOLOGY

ORIGINAL ARTICLE

Evaluation of repeat distal transradial access in the anatomic snuffbox

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PURPOSE
There is increasing interest in the distal radial artery in the anatomic snuffbox as an alternative arterial access point, but the durability of the distal radial artery to support repetitive accesses over multiple procedures is not well established. The purpose of this study was therefore to evaluate success rates for repeated left-sided distal transradial access (ldTRA) in the anatomic snuffbox.

METHODS
In this single institution retrospective study, all patients undergoing radioembolization treatments from January 1st, 2019 to May 1st, 2020 were prospectively evaluated for ldTRA. ldTRA was performed by 15 different operators. Exclusion criteria were a left radiocephalic hemodialysis fistula, inability to properly position the arm, Barbeau D waveform, or failed prior ldTRA due to tortuosity. Barbeau patterns, arterial sizes, and success rates at the first, second, and third ldTRA were compared.

RESULTS
Fifty patients were evaluated for ldTRA and 44, 39, and 10 underwent one, two, and three ldTRA attempts for a total of 93 procedures. There was no significant change in Barbeau patterns between the first and second (p = 0.13) or first and third (p = 1.0) ldTRA. There was no significant change in artery size between the first (mean, 2.3 mm; range, 1.5–3.4 mm) and second (mean, 2.3 mm; range, 1.6–3.3 mm) (p = 0.59) and first and third (mean, 2.4 mm; range, 1.9–3.3) (p = 0.45) ldTRA. The success rate was not significantly different between the first (93%, 41/44, 95% CI 81%–99%), second (95%, 37/39, 95% CI 83%–99%), and third (100%, 10/10, 95% CI 69%–100%) procedure (p = 1.0). The asymptomatic occlusion rate was 4.1% (2/49, 95% CI 0%–14%), and subsequent ldTRA was successfully completed in both patients with occlusions. There were no hemorrhagic or ischemic complications.

CONCLUSION
Success rates are indistinguishable among first, second, and third time ldTRA suggesting that this is a durable access point.

The radial artery has been established as a favorable arterial access point for endovascular procedures, with the potential benefits of reduced risk of complications (1) and increased patient comfort (2, 3) compared with the common femoral artery. As an extension to conventional transradial access (cTRA) upstream of the radial styloid, there has recently been interest in distal transradial access (dTRA) in the anatomic snuffbox as an alternative radial artery access point (4, 5).

For interventional radiologists several benefits of left-sided distal transradial access (ldTRA) have been proposed. ldTRA with the patient's hand across the lower abdomen simulates the positioning of right common femoral artery access, a potentially more ergonomic configuration for operators used to working right-handed (6). In this location, the left arm is tucked across the body in a more compact position for cone beam computed tomography (CT) (4). Beyond these ergonomic considerations, it has been suggested that dTRA may reduce the risk of injury to the palmar arch compared with cTRA (4) although this remains to be shown empirically (5).

One limitation of dTRA compared with cTRA is that dTRA is less extensively studied. In particular, the durability of this slightly smaller (4) access point which is associated with a

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slightly higher failure rate (5, 7) for repeat procedures is not well established. Although the occlusion rate is reportedly low (5), few studies have specifically reported outcomes for repeated ldTRA attempts (6, 8).

The purpose of this study was to evaluate success rates for repeated left-sided distal transradial access in the anatomic snuffbox.

Methods

Patient population

This single institution retrospective study was approved by the Institutional Review Board (Pro00105754) and was conducted in accordance with the Ethical Principles for Medical Research Involving Human Subjects in the Helsinki Declaration in 1975 (revised in 2000). A waiver for informed consent was obtained. For a 16 month period from January 1st, 2019 to May 1st, 2020, all patients referred for yttrium-90 radioembolization for hepatic malignancies were prospectively evaluated for ldTRA (Fig. 1). Radioembolization was chosen due to its elective nature, and its requirements for repeated arterial accesses and cone beam CT (9). Exclusions to ldTRA were the presence of a left radiocephalic arteriovenous hemodialysis fistula, inability to position the left arm across the lower abdomen, pattern D at Barbeau testing, or failure of a prior ldTRA attempt due to vessel tortuosity. Small radial artery size, radial artery occlusion, or prior failed ldTRA for reasons other than tortuosity did not preclude attempted ldTRA. ldTRA was attempted by one of 14 interventional radiology fellows who performed a median of 5 procedures (range, 1–13) or by a single board certified fellowship trained interventional radiology attending with 4 years' experience who performed 9 procedures. No operator had experience with ldTRA prior to January 1st, 2019. Patient demographics were determined from review of the electronic medical record (Table 1).

Main points

- Repeated distal transradial access in the anatomic snuffbox was highly successful.
- Even inexperienced operators achieved success immediately after adopting this technique.
- Left-sided distal transradial access has ergonomic advantages during interventional radiology procedures requiring microcatheter work and cone-beam computed tomography.

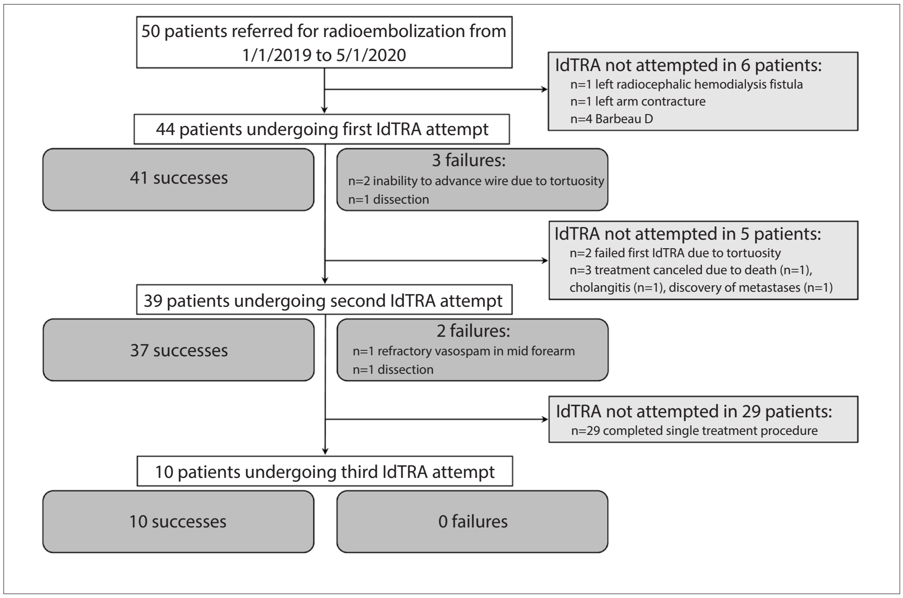

Figure 1. Flowchart showing study population. ldTRA, left-sided distal transradial access.

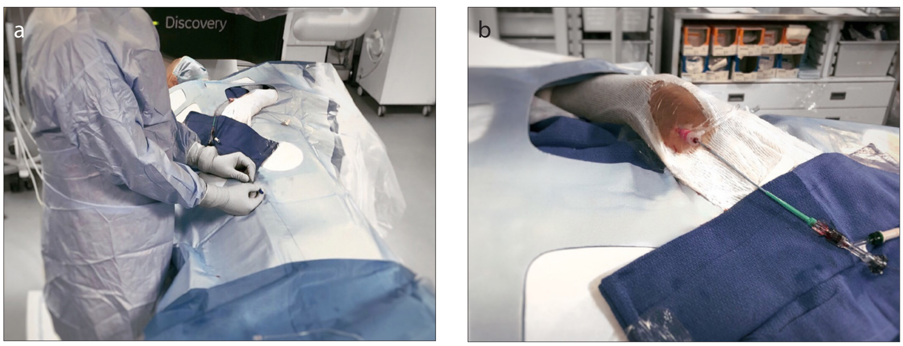

Figure 2. a, b. Illustration of procedural working position.

Left-sided distal transradial access technique

After performing a Barbeau test, the patient's left arm was positioned across the lower abdomen (Fig. 2). The distal radial artery was visualized in the anatomic snuffbox using a linear 15-7 or 18-8 MHz ultrasound transducer and the size was recorded. The artery was punctured under real-time ultrasound guidance and a 5 French (F) 10 cm hydrophilic sheath was placed (Glidesheath Slender®, Terumo Medical Corp.). After access, 3000 units of intravenous heparin were administered, followed by 1000 units per hour throughout the duration of the procedure. Intraarterial nitroglycerin 300 units and verapamil 2.5 mg were administered through the access sheath. A 5 F 110 cm long catheter (Radifocus® Optitorque™ Jacky Radial or Sarah Radial, Terumo Medical Corp.) was advanced over a guidewire to select the mesenteric arteries. Hepatic arteriography was carried out using either a 2.0, 2.4, or 2.8 F 150 cm long microcatheter (Progreat®, Terumo Medical Corp.) inserted coaxially through the 5 F catheter. Cone beam CT was performed for all patients without repositioning the arm.

After completion of the procedure, intraarterial nitroglycerin 300 units and verapamil 2.5 mg were again administered through the radial access sheath prior to sheath removal unless the interventional radiologist deemed that hypotension or bradycardia precluded their use. The access sheath was pulled back and a left-handed distal radial artery compression band (PreludeSYNC DISTAL™, Merit Medical) was applied (Fig. 3). The compression balloon was inflated with 10 mL of air and the access sheath was removed fully. Air was then removed from the balloon until a flash of blood was seen at the cutaneous puncture site. The balloon was then inflated with an

Table 1. Patient demographics and procedural characteristics

Characteristic	First ldTRA (n=44)	Second ldTRA (n=39)	Third ldTRA (n=10)
Age (years)	66 (39–87)	66 (39–87)	64 (49–80)
Male sex, n (%)	35 (80)	32 (82)	8 (80)
Days since prior ldTRA		14.6 (7–28)	53.2 (28–185)
Barbeau, n (%)			
A	27 (61)	18 (46)	6 (60)
B	14 (32)	18 (46)	3 (30)
C	3 (7)	3 (8)	1 (10)
ldTRA performed by fellow, n (%)	40 (91)	35 (90)	9 (90)
Operator's number of prior ldTRA	3.5 (0–11)	4.1 (0–12)	4.1 (0–12)
Distal radial artery size (mm)	2.3 (1.5–3.4)	2.3 (1.6–3.3)	2.4 (1.9–3.3)
Heparin (units)[a]	3400 (3000–5000)	3100 (3000–4000)	3300 (3000–6000)
Nitroglycerin (µg)	530 (300–600)	530 (300–600)	570 (300–600)
Verapamil (mg)	4.6 (2.5–5.0)	4.3 (2.5–5.0)	4.8 (2.5–5.0)
Complications	2 asymptomatic distal radial artery occlusions	0	0

Data are presented as mean (range) unless otherwise noted.
ldTRA, left-sided distal transradial access.
[a]One patient not administered heparin due to allergy.

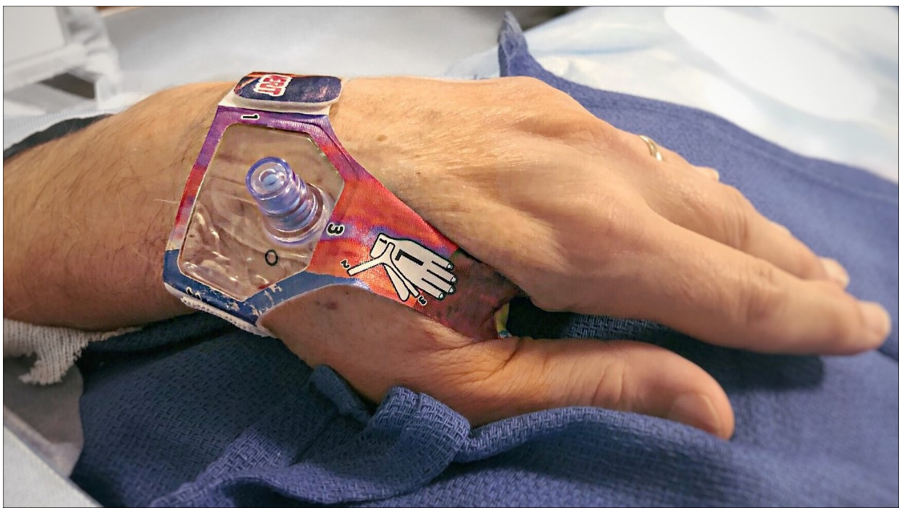

Figure 3. Illustration of distal radial compression band after sheath removal.

additional 2 mL of air. Beginning 30 minutes after application of the compression band, 3 mL of air was released from the balloon every 15 minutes until empty. In the event of bleeding at the access site, the 3 mL of air was reintroduced and then after a 30 minute delay air was again released every 15 minutes in 3 mL increments.

Statistical analysis

All statistical analyses were performed using R version 3.5.1 (R Foundation for Statistical Computing) (10). Barbeau classifications at the time of first, second, and third ldTRA were compared using McNemar's test. Arterial sizes at the time of each ldTRA were compared using paired t-tests. Success rates, defined as completion of all aspects of the procedure via ldTRA, were compared using Fisher's exact test. Predictors of ldTRA failure were evaluated using mixed effects logistic regression with a patient specific random effects term to account for repeated measures on each patient. Given the low overall number of failures, only univariable regression analyses were performed. p values less than 0.05 were considered statistically significant.

Results

Among 44 patients undergoing first time ldTRA, the success rate was 93% (41/44, 95% CI 81%–99%). Two ldTRA failures were due to arterial tortuosity (Fig. 4) and one was due to dissection; all 3 cases were completed via cTRA. The patient in whom first time ldTRA failed due to dissection went on to successful ldTRA at the time of the second procedure.

Among 39 patients undergoing second time ldTRA, there was no statistically significant difference in the Barbeau classifications between the first and second ldTRA procedures (n=32 with identical classifications, n=6 classified as A at the first ldTRA and B at the second, n=1 classified as B at the first and A at the second; $p = 0.13$). The mean distal radial size as measured by ultrasound was unchanged between successive ldTRA procedures (mean difference 0.0, 95% CI -0.1 to 0.1, $p = 0.59$). The success rate at the second ldTRA attempt was 95% (37/39, 95% CI 83%–99%). One failure was due to dissection and the procedure was completed via cTRA, and one failure was due to refractory vasospasm in the mid forearm necessitating common femoral artery access. The success rate at the second ldTRA attempt was not significantly different than at the first ldTRA attempt (OR=1.3, 95% CI 0.15–17, $p = 1.0$).

Table 2. Predictors of successful ldTRA			
Characteristic	Successful ldTRA (n=88)	Failed ldTRA (n=5)	*p*
Age (years)	65 (39–87)	73 (61–83)	0.87
Male sex, n (%)	72 (82)	3 (60)	0.67
Barbeau, n (%)			
A	48 (55)	3 (60)	1.0
B	34 (39)	1 (20)	
C	6 (7)	1 (20)	
ldTRA performed by fellow, n (%)	79 (90)	5 (100)	1.0
Operator's number of prior ldTRA	3.9 (0–12)	2.0 (0–8)	0.23
Distal radial artery size (mm)	2.3 (1.5–3.4)	1.9 (1.8–2.2)	0.35
Patient's number of prior ldTRA	0.6 (0–2)	0.4 (0–1)	0.43

Data are presented as mean (range) unless otherwise noted.
ldTRA, left-sided distal transradial access.

Figure 4. Failure of ldTRA due to tortuosity. Note vasospasm *(arrow)* from attempts at advancing a guidewire through the tortuous distal radial artery from the initial access site. The procedure was successfully completed from the conventional TRA as shown.

Among 10 patients undergoing third time ldTRA, there was no significant difference in the Barbeau classifications between the first and third ldTRA procedures (n=6 with identical classifications, n=2 classified as A the first ldTRA and B at the third, n=2 classified as B at the first and A at the third; p = 1.0). The mean artery size was not significantly different compared with the first ldTRA procedure (mean difference, -0.1, 95% CI -0.4 to 0.2, p = 0.45). The success rate at the third ldTRA attempt was 100% (10/10, 95% CI=69%–100%), not significantly different than at the first ldTRA attempt (p = 1.0).

There were two patients who were found to have asymptomatic occlusion of the distal radial artery after the first ldTRA: a 61-year-old female with a 1.6 mm artery in whom the 5 F sheath was in place for 45 minutes during the procedure and in whom the compression band was applied for 60 minutes afterward, and a 79-year-old male with a 2.0 mm artery in whom the 5 F sheath was in place for 61 minutes followed by 98 minutes of compression due to prolonged oozing at the puncture site. Both underwent successful second ldTRA despite the occlusion, and the male patient underwent a successful third ldTRA with the artery found to be patent at the time of the third ldTRA. Based on imaging documented radial artery patency in patients in whom repeat ldTRA was attempted, the occlusion rate was 4.1% (2/49, 95% CI 0%–14%). There were no hemorrhagic or ischemic complications.

Compared with successful ldTRA procedures, failed ldTRA attempts tended to occur in older female patients with smaller arteries and were performed by fellows who tended to have less prior ldTRA case experience (Table 2). However, none of these features reached statistical significance.

Discussion

Potential advantages of radial artery access for endovascular procedures have been well documented (1–3). Compared with cTRA, ldTRA has certain ergonomic advantages for interventional radiology procedures, particularly those requiring compact patient positioning for cone beam CT (4), such as yttrium-90 radioembolization mapping and treatment procedures. However, in order to be more widely adopted, ldTRA must be proven to be as reliable and durable as its cTRA counterpart. This study showed indistinguishable success rates for first time versus second and third time ldTRA, suggesting that the distal radial artery in the anatomic snuffbox is a durable access point.

A previous meta-analysis based primarily on non-randomized studies found a 2.3% rate of occlusion after coronary arteriography and intervention performed via dTRA, which compares favorably with occlusion rates after cTRA (5). Although the low rate of occlusion would suggest the opportunity for successful repeat access, few data have been published directly assessing success rates of sequential dTRA. Pua et al. (6) described a 100% success rate in 13 patients who had repeat dTRA procedures. Hadjivassiliou et al. (4) reported successes in all 389 ldTRA procedures in 287 patients, but repeat procedures were not explicitly discussed. Chen et al. (8) described 7 successful repeat dTRA procedures, but in far more cases the authors switched to an alternative radial puncture site for repeat procedures. A study by van Dam et al. (11) described a 90% success rate with 2 failures among 21 repeat dTRA attempts. However, previous studies may suffer from selection bias since data were not uniformly reported on whether any patients were deemed ineligible for repeat dTRA. Such bias is not present in this study which reports the results from a prospectively defined clinical protocol in which ldTRA was attempted in all procedures except for those in which specific exclusion criteria were present. The current study, therefore, bolsters previous data suggesting high success rates for repeat ldTRA.

The overall failure rate of 5.4% in this study is similar to the 5.26% failure rate for dTRA described in the meta-analysis of Hamandi et al. (5), but higher than the failure rate reported in the interventional radiology literature for cTRA at experienced, high volume centers (12). dTRA is reported to be technically more difficult than cTRA based on a larger number of skin punctures and longer time required to gain access (7). However, in this study, once ldTRA was achieved, microcatheter work in the hepatic arteries could be performed right-handed and cone beam CT scans could be conducted quickly and repeatedly, potentially regaining procedure time lost during the initial access.

Hadjivassiliou et al. (4) reported a remarkable 100% success rate for ldTRA among 389 procedures, likely in part due to the expertise of the single operator who performed most of those procedures. In this study, no operator had experience with ldTRA prior to embarking on an exclusive ldTRA approach for yttrium-90 radioembolization patients. In 90% of procedures operators were trainees with varying prior cTRA and pedal artery access experience, and no single operator performed more than 15% of the ldTRA cases. Therefore, the success rates presented here may be more generalizable to the outcomes that could be expected after *de novo* adoption of ldTRA by typical interventional radiologists.

This study has a number of limitations. Although larger than prior studies reporting outcomes of repeat dTRA, the sample size of this study was small. Due to the low number of ldTRA failures, there were no features predicting technical failure of ldTRA which achieved formal statistical significance. All procedures utilized 5 F access sheaths, so the ability of the distal radial artery to withstand repetitive placement of larger sheaths remains unclear. As in other studies, after the final ldTRA procedure, radial artery patency was evaluated at clinic follow-up by physical exam alone and not by Doppler ultrasound (12, 13). A rigorous estimate of the radial artery occlusion rate of 4.1% was based on documented arterial patency at imaging performed at the time of repeat ldTRA procedures, so this rate should not necessarily be extrapolated to later repeated ldTRA procedures. The occlusion rate in this study was slightly higher than in previous reports for dTRA (5) and cTRA (13, 14), although given the small numbers not significantly different. Of note, low dose heparin was administered based on the institutional cTRA protocol which predated more recent evidence of superior efficacy of high dose heparin in preventing radial artery occlusion (15). The study population was predominantly elderly patients with cancer, and therefore the results may not be applicable to other populations. Operator dose was not recorded in this study, and in the procedural working position utilized the operator may be in closer proximity to the X-ray beam. Perhaps most importantly, no comparison was made with alternative TRA strategies. For example, cTRA can be performed with the left arm positioned across the lower abdomen in the same manner as for ldTRA in this study, or as suggested by Lorenzoni et al. (16) the patient can be positioned upside down which may place the operator further from the X-ray beam thus reducing exposure. Future comparisons among these various TRA access strategies may be warranted.

In conclusion, this study demonstrated indistinguishable success rates among first, second, and third time repeated left-sided distal radial artery access in the anatomic snuffbox. These data suggest that ldTRA may represent a suitable access point for interventional oncologic procedures relying on cone beam CT imaging and requiring repeated procedures.

Conflict of interest disclosure

The authors declared no conflicts of interest.

References

1. Ferrante G, Rao SV, Juni P, et al. Radial versus femoral access for coronary interventions across the entire spectrum of patients with coronary artery disease: a meta-analysis of randomized trials. JACC Cardiovasc Interv 2016; 9:1419–1434. [Crossref]
2. Liu LB, Cedillo MA, Bishay V, et al. Patient experience and preference in transradial versus transfemoral access during transarterial radioembolization: a randomized single-center trial. J Vasc Interv Radiol 2019; 30:414–420. [Crossref]
3. 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; 29:38–43. [Crossref]
4. Hadjivassiliou A, Cardarelli-Leite L, Jalal S, et al. Left distal transradial access (ldTRA): A comparative assessment of conventional and distal radial artery size. Cardiovasc Intervent Radiol 2020; 43:850–857. [Crossref]
5. Hamandi M, Saad M, Hasan R, et al. Distal versus conventional transradial artery access for coronary angiography and intervention: A meta-analysis. Cardiovasc Revasc Med 2020; 21:1209–1213. [Crossref]
6. Pua U, Sim JZT, Quek LHH, Kwan J, Lim GHT, Huang IKH. Feasibility study of "snuffbox" radial access for visceral interventions. J Vasc Interv Radiol 2018; 29:1276–1280. [Crossref]
7. Koutouzis M, Kontopodis E, Tassopoulos A, et al. Distal versus traditional radial approach for coronary angiography. Cardiovasc Revasc Med 2019; 20:678–680. [Crossref]
8. Chen SH, Brunet MC, Sur S, Yavagal DR, Starke RM, Peterson EC. Feasibility of repeat transradial access for neuroendovascular procedures. J Neurointerv Surg 2020; 12:431–434. [Crossref]
9. Kis B, Mills M, Hoffe SE. Hepatic radioembolization from transradial access: initial experience and comparison to transfemoral access. Diagn Interv Radiol 2016; 22:444–449. [Crossref]
10. R Development Core Team. R: A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing; 2010.
11. van Dam L, Geeraedts T, Bijdevaate D, van Doormaal PJ, The A, Moelker A. Distal radial artery access for noncoronary endovascular treatment is a safe and feasible technique. J Vasc Interv Radiol 2019; 30:1281–1285. [Crossref]
12. Posham R, Biederman DM, Patel RS, et al. Transradial approach for noncoronary interventions: a single-center review of safety and feasibility in the first 1,500 cases. J Vasc Interv Radiol 2016; 27:159–166. [Crossref]
13. Fischman AM, Biederman DM, Posham R. Reply to: "Comments on: transradial approach for noncoronary interventions: a single-center review of safety and feasibility in the first 1,500 cases". J Vasc Interv Radiol 2016; 27:938. [Crossref]
14. Cenk Turba U, Masrani A, Arslan B. Comments on: transradial approach for noncoronary interventions: a single-center review of safety and feasibility in the first 1,500 cases. J Vasc Interv Radiol 2016; 27:937. [Crossref]
15. Hahalis GN, Leopoulou M, Tsigkas G, et al. Multicenter randomized evaluation of high versus standard heparin dose on incident radial arterial occlusion after transradial coronary angiography: The SPIRIT OF ARTEMIS Study. JACC Cardiovasc Interv 2018; 11:2241–2250. [Crossref]
16. Lorenzoni R, Lisi C, Lazzari M, Bovenzi F. Tools & techniques: Above the knee angioplasty by transradial access. EuroIntervention 2012;7:1118–1119. [Crossref]