**LEFT DISTAL RADIAL ARTERY APPROACH VERSUS CONVENTIONAL RADIAL ARTERY FOR CORONARY ANGIOGRAPHY**

**Mahmoud Shawky Abd El-Moneum1, Mohamed Asem Alam1, Hesham Khaled Rashid1, Mohamed Abd El-Shafy Tabl1**

1Department of Cardiology, Benha University Hospital, Benha City, Egypt

Fareed Nada street, Benha,Qalubiya governorate, 13511 Arab Republic of Egypt

**Abstract**

**Objectives:** We aimed to evaluate feasibility, contrast utilization and complications of trans-radial approach comparing the left distal trans-radial artery (lt. dTRA) access in the anatomical snuffbox versus conventional right trans-radial artery (rt. TRA) access in coronary angiography procedures.

**Subjects and Methods:** This study was conducted on one hundred (100) patients who underwent coronary angiography (50 patients via left distal trans-radial approach & 50 patients via conventional right trans-radial approach) and was performed in the department of cardiology, Benha University Hospital, Benha City, Egypt. All patients performed ECG, echocardiography, arterial doppler pre and post procedures.

**Results:** In comparison with conventional right trans-radial artery (rt. TRA), Our study revealed that performing coronary angiography via lt. dTRA had more difficulties at which it had significantly more failure rate to get puncture (14% in lt. dTRA group and 2% in rt. TRA group, P = 0.03) and high significantly more time to insert a sheath (5.08±0.75 minutes in lt. dTRA group and 4.02±0.55 minutes in rt. TRA group, P˂0.001) but with significantly less contrast volume required (56.50±8.93 ml in lt. dTRA group and 63.20±11.68 ml in rt. TRA group, P=0.002). Also, lt. dTRA approach had significantly less incidence to cause radial artery occlusion (RAO) (8% in lt. dTRA group and 20% in rt. TRA group, P=0.040) and less incidence to cause bleeding (6% in lt. dTRA group and 8% in rt. TRA group, P=0.500) without significant difference but with more incidence to cause infection (4% in lt. dTRA group and 2% in rt. TRA group, P=0.558) without significant difference. Patients were more satisfied when procedures performed via lt. dTRA approach (92% in lt. dTRA group and 80% in rt. TRA group, P=0.084) (non-significant deference) and they had less hospital stay time (3.92±1.06 hours in lt. dTRA group and 5.56±0.951 hours in rt. TRA group, P˂0.001) (highly significant deference).

**Conclusion:** Compared to conventional right trans-radial artery (rt. TRA) access for coronary angiography procedure, left distal trans-radial artery (lt. dTRA) access has more failure rate to get puncture and more time to insert sheath but with less contrast volume required, less incidence of RAO and less hospital stay time.

**Keywords:** Left distal trans-radial; Radial; Snuff box; Coronary angiography.

**Introduction**

Since its first performance in 1929, cardiac catheterization has continued to develop [1]. The advancement in technology and understanding the physiological properties of the vascular system have contributed to new vision into coronary angiography procedures. In concerning with arterial entry sites, a variety of research studies have been undertaken to establish which entry site is better suited for individual patients and situations. Notwithstanding the ease of access of femoral artery to coronary angiography, vascular-related complications and bleeding have resulted in increased morbidity , deaths and hospitalization, especially when anticoagulation and antiplatelet therapy are implemented[2]. The Femoral approach was compared in several randomized and observational trials with radial approach for both coronary angiography and interventional procedures. The established results were the safety of the patient and satisfaction, as well as reduced bleeding complications and immediate post-procedural mobilization as significant advantages of radial access. [3]. Based on the findings of these randomized trials, trans-radial access is taken as the default coronary access technique [4]. The majority of operators choose the right radial artery, as they operate on the patients' right side. On the other hand, the occlusion of the radial arteries, the underdeveloped right radial artery, extreme tortuosity, sclerosis, calcification, past or potential use of the proper radial artery as a free arterial graft leads to change the operator decision to use left radial artery. [5]. Otherwise, left radial access may be exhausting for the operator as he should bend over the patient to insert the sheath and deal with it. This annoying location could make the catheterization process uncomfortable and it is probable that he moves to another artery access site. A possible way to provide a convenient position for both the patient and the operator is to reach through left distal radial artery situated on the anatomical snuffbox or "fossa radialis" [5]. Anatomical snuffbox (AS) is an area of depression within the radial portion of the wrist. It is seen when you stretch the thumb. It is laterally surrounded by the tendons of the abductor pollicis longus and extensor pollicis brevis muscles and medially by the extensor pollicis longus muscle tendon. The base of this triangular region is created by the distal radius, scaphoid, trapezium and base of the first metacarpal bone. [6].

**Aim of the work**

The aim of this study was to evaluate feasibility, contrast utilization and complications of trans-radial approach comparing the left distal trans-radial artery (lt. dTRA) in the anatomical snuffbox versus conventional right trans-radial artery (rt. TRA) approach in coronary angiography procedures.

**Study design and population:**

This study was conducted over one year period from July 2019 to July 2020 and was performed in the department of cardiology, Benha University Hospital, Benha City, Egypt on one hundred (100) patients who underwent diagnostic coronary angiography (50 patients via left distal trans-radial artery (lt. dTRA) approach who represented group A & 50 patients via conventional right trans-radial artery (rt. TRA) approach who represented group B). All patients were indicated for coronary angiography. Exclusion criteria were refusal of patients, patients in whom radial approach were contraindicated, Patients who suffer from previous unsuccessful or complicated Radial approach, in this case the femoral approach may be more suitable for the operator and in patients with moderate to sever renal impairment or coagulopathy. The protocol was approved by the hospital’s ethics committee.

*All participants included in our study had been subjected to:*

* Informed written consent for coronary angiography via right trans-radial or left distal trans-radial Approach.
* Complete history taken: included history of hypertension, diabetes mellitus, dyslipidemia, peripheral vascular disease, smoking habit and analysis of chest pain.
* physical examination: included:

1) General examination e.g. heart rate and blood pressure.

2) Local examination of heart e.g. heart sounds and cardiac murmurs.

* Investigations:
* 12 lead ECG: A 12-lead surface ECG was done for each patient on admission. The electrocardiograms were recorded at a paper speed of 25 mm/s and an amplification of 10 mm/mV with special assessment for heart rate, rhythm, ST-T changes.
* Laboratory investigations: blood samples were dragged from all participants and the following investigations were performed: Serum creatinine, PT, PTT, INR, CBC, virology markers and HbA1C.
* Echo-doppler study: A conventional transthoracic echocardiographic evaluation was performed in all patients after hospital admission with special assessment for the left ventricular systolic function, valve assessment and regional wall motion.
* Arterial doppler pre and post procedure to detect blood flow and complications.
* Procedure:

After gaining approval from the institutional review board and all consents and pre-procedural tests, patients were put in a typical supine position on the catheterization lab table. Their arm was kept immobilized and the wrist was hyperextended and then wrapped in a sterilized way, access was made to the right radial or left distal radial artery by:-

**A-** Left distal trans-radial approach technique (Anatomical Snuff Box):

* The patient had been wrapped with a sterilized drape during disinfection. The operator bring the patient's left hand to his right iliac area and took a nearby site, then subcutaneous 3 ml Lidocaine administered at the Snuff Box area.
* The patient was pinched his thumb inside the other four fingers to bring the artery superficially. The radial artery was penetrated by a 21 G needle with angle of 30-45 degrees.
* The needle was pointed proximally to the direction of the strongest pulse in snuff box triangle.
* Following the succeeded puncture in the anterior wall of the radial artery, the guide wire was easily advanced through the needle and used to direct the sheath through the artery, accompanied by a slight incision in the skin, followed by the insertion of a 6F radial sheath.
* Thereafter, 0.2 mg of nitroglycerin and 500 IU heparin were administered. At the level of the patient's thigh, operator took a position to advance the diagnostic guide wire and the diagnostic catheters (left and right) to proceed the coronary angiography.
* The sheath had been removed after the angiography and pressure was placed over the arteriotomy site to maintain hemostasis with implementation of TR – band.

**B-** Conventional right trans-radial approach technique:

* The patient had been wrapped with a sterilized drape during disinfection. The operator took up a position near right upper limb of the patient then subcutaneous 3 ml Lidocaine injected at the site of radius bone styolid process.
* The radial artery was penetrated at an angle of 45 degrees, 1 cm proximal to the stylized radius process with a 21 G needle.
* Following the succeeded puncture in the anterior wall of the radial artery, the guide wire was easily advanced through the needle and used to direct the sheath through the artery, accompanied by a slight incision in the skin, followed by the insertion of a 6F radial sheath.
* Thereafter, 0.2 mg of nitroglycerin and 5000 IU heparin were administered. At the level of the patient's thigh, operator took a position to advance the diagnostic guide wire and the diagnostic catheters (left and right) to proceed the coronary angiography.
* The sheath had been removed after the angiography and pressure was placed over the arteriotomy site to maintain hemostasis with implementation of TR – band.

Follow up:

Arterial Doppler had been performed post procedural for all the patients in the two groups to assess the flow through the artery and post procedural complications.

**Outcomes of the procedures in the two groups had been reviewed including:**

* Success and failure rate of cannulation.
* Post Catheterization Radial Artery Occlusion (RAO) and thrombosis.
* Bleeding or hematoma.
* Infection.
* Total duration of the procedure.
* Discharge time and satisfaction between groups.

**Statistical analysis:**

Using an IBM compatible personal computer with SPSS statistical package version 23 **(SPSS Inc. Released 2015. IBM SPSS statistics for windows, version 23.0, Armnok, NY: IBM Corp.),** results were collected, tabulated and statistically analyzed by an

There were two types of statistical analysis:

**a) Descriptive statistics** e.g. g. Number (No), percentage (%), mean (X¯) and standard deviation (SD).

* Arithmetic mean (x): The measure used for central tendency.
* Standard deviation (SD): The measure for dispersion.
* Percentage (%).
* Median: was used as a measure of central tendency.
* Range: was used as a measure of dispersion

**b) Analytic statistics:**

* Chi-squared test (χ2): a parametric test used to find the correlation between two or more qualitative variables.
* Fischer exact test: for 2 x 2 tables, in case the predicted cells count of more than 25 percent of cases were less than 5 and the significant p-value < 0.05.

- Student t-test: is a significant test used for comparing with independent parametric data between two classes of quantitative variables

**P value at 0.05 was used to indicate the significance:**

• P-value > 0.05 means non- significant statistically.

• P-value ≤ 0.05 is used to mean significant statistically.

• P-value ≤ 0.001 means of high significant statistically.

**RESULTS**

**Demographic features of studied patients:**

Our study included one hundred (100) patients who underwent coronary angiography (50 patients via left distal trans-radial approach (lt. dTRA) which represented group A & 50 patients via conventional right trans-radial approach (rt. TRA) which represented group B).

Table (1): Distribution of studied patients according to demographic features (n = 100)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **P value** | **Test of sig.** | **Group B**  **No=50** | **Group A**  **No=50** | **Demographic features** |
| 0.944  Ns | t  0.071 | 51.46±8.47  36-65  54 | 51.34±8.53  35-65  54 | **Age**  Mean ± SD  Range  Median |
| 0.826  NS | **χ**2  0.049 | 36(72%)  14(28%) | 35(70%)  15(30%) | **Sex**  Male  Female |

t=student’s t test χ2 chi-square test NS=non-significant

**Risk factors of studied patients**:

As regarding risk factors, there was no significant difference between groups. Out of the 100 patients, 11 (22%) were diabetics in group (A) whereas 10 (20%) members of group (B) (p=0.806). 30 (60%) patients had dyslipidemia in group (A) whereas 29 (58%) members of group (B) (p=0.839). 13 (26%) were hypertensives in group (A) whereas 15 (30%) members of group (B) (p=0. 656). 11 (22%) were smokers in group (A) whereas 10(20%) members of group (B) (p=0.806) (table 2).

Table (2): Distribution of the studied patients according to risk factors (n = 100)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **P value** | **χ2** | **Group B**  **No=50** | | **Group A**  **No=50** | | **Risk factors** |
| **%** | **No** | **%** | **No** |
| 0.806  NS | 0.060 | 20  80 | 10  40 | 22  78 | 11  39 | **DM**  Yes  No |
| 0.656  NS | 0.198 | 30  70 | 15  35 | 26  74 | 13  37 | **HTN**  Yes  No |
| 0.839  NS | 0.041 | 58  42 | 29  21 | 60  40 | 30  20 | **Dyslipidemia**  Yes  No |
| 0.806  NS | 0.060 | 20  80 | 10  40 | 22  78 | 11  39 | **Smoking**  Yes  No |

χ2 chi-square test NS=non-significant

**Procedural aspects of studied patients**

As regarding procedural aspects of the groups, there was a significant difference between the groups as regarding failure rate to get puncture at which operators failed to get puncture in 7 (14%) of group (A) while there was 1 (2%) failed puncture in group (B) (p=0.03). As regarding time to insert sheath, there were 5.08±0.75 minutes for sheath insertion in group (A) and 4.02±0.55 minutes in group (B) (p ˂0.001) with highly significant difference between groups. As regarding total duration of procedure, there were 19.34 ± 1.81 minutes in group (A) and 19.90 ± 1.79 minutes in group (B) (p=0.124) with no significant difference between groups. As regarding contrast volume used in procedure, there was a significant difference between both groups at which operators used about 56.50 ± 8.93 mL of contrast in group (A) and 63.20 ± 11.68 mL of contrast used in group (B) (p=0.002).(Table 3)

Table (3): comparison between studied groups as regard procedural aspects (n=100)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **P value** | **Test of sig.** | **Group B**  **No=50** | | **Group A**  **No=50** | | **Procedural aspects** |
| **%** | **No** | **%** | **No** |
| 0.03  S | χ2  4.9 | 2  98 | 1  49 | 14  86 | 7  43 | **Failure to get puncture**  Yes  No |
| ˂0.001  HS | t  8.03 | 4.02±0.55  3-5  4 | | 5.08±0.75  4-7  5 | | **Time to insert sheath (minutes)**  Mean ± SD  Range  Median |
| 0.124  NS | t  1.55 | 19.90±1.79  17-23  19 | | 19.34±1.81  17-23  19 | | **Total procedure duration (minutes)**  Mean ± SD  Range  Median |
| 0.002  S | t  3.22 | 63.20±11.68  40-100  60 | | 56.50±8.93  40-80  60 | | **Contrast volume**  Mean ± SD  Range  Median |

FXT= Fisher’s exact test t=student’s t test S=significant NS=non-significant HS=High significant

**Complications of studied patients**

As regarding post-procedural complications, there was bleeding in 3(6%) of cases of group (A) and in 4(8%) cases of group (B) (p=0.500) with no significant difference between the groups. Infection occurred in 2(4%) of cases of group (A) while that occurred in 1(2%) case of group (B) (p=0.558) with no significant difference between groups. Thrombosis and radial artery occlusion (RAO) occurred in 3(6%) of cases of group (A) while that occurred in 10(20%) cases of group (B) (p=0.040) with a significant difference between 2 groups (Table 4).

Table (4): comparison between studied groups as regard complications (n = 100)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **P value** | **Test of sig.** | **Group B**  **No=50** | | **Group A**  **No=50** | | **Complications** |
| **%** | **No** | **%** | **No** |
| 0.500  NS | FXT  0.154 | 8  92 | 4  46 | 6  94 | 3  47 | **Bleeding**  Yes  No |
| 0.558  NS | FXT  0.344 | 2  98 | 1  49 | 4  96 | 2  48 | **Infection**  Yes  No |
| 0.040  S | χ2  4.18 | 20  80 | 10  40 | 6  94 | 3  47 | **Thrombosis**  Yes  No |

FXT= Fisher’s exact test χ2 chi-square test NS=non-significant S=significant

**Satisfaction of studied patients**

Regarding patient satisfaction, there was no significant difference between the 2 groups, as there were 4(8%) patients from group (A) were not satisfied while there were 10(20%) patients from group (B) (p=0.084).

Table (5): comparison between studied groups as regard Patients satisfaction (n = 100)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **P value** | **Test of sig.** | **Group B**  **No=50** | | **Group A**  **No=50** | | **Patients satisfaction** |
| **%** | **No** | **%** | **No** |
| 0.084  NS | **χ**2  2.99 | 80  20 | 40  10 | 92  8 | 46  4 | Yes  No |

χ2 chi-square test NS=non-significant

**Hospital stay time of studied patients**

The rt. TRA was associated with highly significant increase in hospital stay time after procedure in comparison with lt. dTRA (5.56±0.951 hours vs 3.92±1.06 hours respectively, *P*<.001).

Table (6): comparison between studied groups as regard hospital stay time (n=100)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **P value** | **Test of sig.** | **Group B**  **No=50** | | **Group A**  **No=50** | | **Hospital stay time** **(Hours)** |
| **%** | **No** | **%** | **No** |
| ˂0.001  HS | **t**  8.11 | 5.56±0.951  4-8  6 | | 3.92±1.06  3-8  4 | | Mean ± SD  Range  Median |

t =student’s t test HS=High significant

**Discussion**

Coronary artery disease (CAD) is one of the most prevalent causes of morbidity and mortality worldwide [7]. Trans-radial arterial technique (TRA) is a relatively easy way of intervention for coronaries [8]. Recently, interventional cardiologists have begun to follow a modulation of the trans-radial approach, the left distal trans-radial technique (lt. dTRA) for coronary procedures [9].

In our study we aimed to evaluate feasibility, contrast utilization and complications of trans-radial approach comparing the left distal trans-radial (lt. dTRA) versus conventional right trans-radial (rt. TRA) approach in coronary angiography procedures.

This study showed that out of the 100 patients, 35 (70%) were males and 15 (30%) were females in (group A) whereas 36 (72%) members of the (group B) were males and 14 (28%) were females. No significant variation between groups regarding gender. The mean ± SD ages were distributed between both groups as 51.34±8.53 and 51.46±8.47 respectively with no significant difference between groups. Our results were in agreement with the study conducted by **Roghani-Dehkordi et al.** which reported that in 159 patients, men were 76% with age 58.1 ± 10.5 years and women were 24% with age 61.2 ± 9.6 years [10]. But our results were in disagreement with **Brunet et al**. regarding sex of patients who reported that male participants comprised only 21.2% of the recruited participants [11].

This study showed that regarding risk factors, 11 (22%) were diabetics in group (A) whereas there were 10 (20%) members of the group (B), 30 (60%) had dyslipidemia in group (A) whereas there were 29 (58%) members of the group (B), 13 (26%) were hypertensives in group (A) whereas there were 15 (30 %) members of the group (B) and 11 (22%) were smokers in group (A) whereas there were 10 (20 %) members of the group (B). Our results were in disagreement with **Soydan & Akın** who documented that the most common risk factor for patients who experienced coronary angiography via left distal radial artery was hypertension with rate of 61.1 percent [12].

This study showed that regarding procedural aspects, there was a significant difference between the groups as regarding failure rate to get puncture at which operators failed to get puncture in 7 (14%) of group (A) while there was 1 (2%) failed puncture in group (B) (p=0.03). Our results were in agreement with the study conducted by **Brunet et al.** which reported that failure rate to get puncture via distal radial approach was 8%, with the majority of failed cases converted to trans-femoral artery for convenience [11]. Our results were in disagreement with the study conducted by **Mizuguchi et al.** which reported that failure rate for initial puncture was 0.4%, with conversion to contralateral distal radial artery [13].

This study showed that contrast volume used for coronary angiography in group (A) was significantly less than used in group (B) at which it was 56.50±8.93 mL and 63.20±11.68 mL respectively, P = 0.002. This was in disagreement with **Coughlan et al.** who showed that there was no statistically significant difference in contrast dose used for coronary angiography in distal trans-radial versus conventional trans-radial artery access (82.93 ± 23 vs 92.1 ± 33 mL respectively, P = 0.1215) [14].

This study showed that total procedure time in group (A) in comparison with group (B) was non significantly shorter as time distributed was 19.34±1.81 min and 19.90±1.79 min between groups respectively. This was in agreement with **Coughlan et al.** who showed that Procedural length did not vary significantly between groups (28.95 ± 5.89 vs 29.76 ± 8.16 min, P = 0.5824) [14].

Arterial Doppler had been performed pre-procedural and post-procedural for all the patients in the two groups to assess the flow through the radial artery and to evaluate the post-procedural complications especially radial artery occlusion (RAO).

This study showed that the rate of RAO was significantly higher with group B (20%) than group A (6%) (P=0.040). Our results were in agreement with a study of 1320 patients who subjected to dTRA for coronary intervention, late RAO was observed in few cases about 0.61% [15]. Our results were in disagreement with **Sinha et al.** who showed that the rate of RAO in conventional radial artery was low (1–6%) [9].

Regarding bleeding, there was no significant difference between the 2 groups, as there were 3(6%) patients from group (A) had bleeding while there were 4(8%) patients from group (B) had bleeding (p=0.500). Our results were in agreement with **Wretowski et al.** who documented that only single patient on oral anticoagulation with DAPT had minor bleeding and had treated conservatively [16].

Regarding patient satisfaction, there was no significant difference between the 2 groups, as there were 4(8%) patients from group (A) were not satisfied while there were 10(20%) patients from group (B) (p=0.084). This was in agreement with **Koutouzis et al.** who found that slightly higher rates of patient satisfaction in the distal trans-radial group than in the conventional trans-radial artery group, although this difference was not significant [17].

Our study showed that rt. TRA was associated with highly significant increase in hospital stay time after procedure in comparison with lt. dTRA (5.56±0.951 hours vs 3.92±1.06 hours respectively, *P*<.001). This was in agreement with **Coughlan et al.** who showed that from the other benefits of snuff box access was shorter discharge time due to statistically significant decreases in the time required for radial artery compression [14].

**Conclusion**

In conclusion, Compared to conventional right trans-radial artery (rt. TRA) access for coronary angiography procedure, left distal trans-radial artery (lt. dTRA) access has more failure rate to get puncture and more time to insert sheath but with less contrast volume required, less incidence of RAO and less hospital stay time.

**Limitations**

* This study is a single-center study.
* Small sample size.
* Short duration of study.

**Financial support and sponsorship**

Nil

**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Mueller RL and Sanborn TA (1995): The history of interventional cardiology; cardiac catheterization, angioplasty and related interventions. Am Heart J; 129: 146-72.
2. Brueck M, Bandorski D, Kramer W, et al. (2009): A randomized comparison of transradial versus trans­femoral approach for coronary angiography and angioplasty. JACC Cardiovasc Interv; 2: 1047-54.
3. Valgimigli M, Gagnor A, Calabró P, et al. (2015): MATRIX Investigators. Radial versus femoral access in patients with acute coronary syndromes undergoing invasive management: a randomised multicentre trial. Lancet; 385: 2465-76.
4. Agostoni P, Biondi-Zoccai GG, De Benedictis ML, et al. (2004): Radial versus femoral approach for ­percutane­ous coronary diagnostic and interventional procedures; System­atic overview and meta-analysis of randomized trials. J Am Coll Cardiol; 44: 349-56.
5. Kiemeneij F (2017): Left distal transradial access in the anatomical snuff­box for coronary angiography (ldTRA) and interventions (ldTRI). Euro Intervention 2017; 13: 851-7.
6. Cerda A and del Sol M (2015): Anatomical snuffbox and it clinical significance. A literature review. Int J Morphol; 33: 1355-60.
7. Keeley E, Boura J and Grines C (2003): Primary angioplasty versus intravenous thrombolytic therapy for acute myocardial infarction: a quantitative review of 23 randomized trials. Lancet; 361:13–20.
8. [Chiung J.](https://onlinelibrary.wiley.com/action/doSearch?ContribAuthorStored=Wu%2C+Chiung-Jen) , [Ping H.](https://onlinelibrary.wiley.com/action/doSearch?ContribAuthorStored=Lo%2C+Ping-Han) , [Kuan C](https://onlinelibrary.wiley.com/action/doSearch?ContribAuthorStored=Chang%2C+Kuan-Cheng), et al. (1997): Transradial coronary angiography and angioplasty in Chinese patients. Catheterization and cardiovascular diagnosis. 40(2): p. 159-163.
9. Sinha S, Jha M, Mishra V, et al. (2017): Radial artery occlusion - incidence, predictors and long-term outcome after transradial catheterization: clinico-Doppler ultrasound-based study (raiL-TraC study). Acta Cardiol ;72:318–27.
10. Roghani-Dehkordi F, Hashemifard O, Sadeghi M et al. (2018): Distal accesses in the hand (two novel techniques) for percutaneous coronary angiography and intervention. ARYA Atherosclerosis, 14 (2): 95-9.
11. Brunet MC, Chen SH, Sur S et al. (2019): Distal transradial access in the anatomical snuffbox for diagnostic cerebral angiography. J Neurointerv Surg., 11 (7): 710-713.
12. Soydan E and Akın M (2018): Coronary angiography using the left distal radial approach - an alternative site to conventional radial coronary angiography. Anatol J Cardiol., 19: 243-8.
13. Mizuguchi Y, Izumikawa T, Hashimoto S et al. (2019): Efficacy and safety of the distal transradial approach in coronary angiography and percutaneous coronary intervention: a Japanese multicenter experience. Cardiovascular Intervention and Therapeutics, 3: 1-6.
14. Coughlan J, Zebrauskaite A, Arnous S, et al. (2018): Left distal trans-radial access facilitates earlier discharge post-Coronary angiogrophy. J Interv Cardiol. 31:964-968.
15. Babunashvili A. (2018): TCT-810 Novel distal transradial approach for coronary and peripheral interventions. J Am Coll Cardiol. 72:B323.
16. Wretowski D, Krakowian M, £abyk A, et al. (2019): Very distal transradial approach (VITRO) for coronary interventions. Postêpy w Kardiologii Interwencyjnej= Advances in Interventional Cardiology, 15(1), 42.
17. Koutouzis M, Kontopodis E, Tassopoulos A, et al. (2018): Distal versus traditional radial approach for coronary angiography. Cardiovasc Revasc Med., :30439-1.