SANAMED
2016; 11(2): 87–92
ISSN-1452-662X

DOI: 10.5937/sanamed1602087Z
UDK: 616.131-007.4(497.7)
ID: 224543244
Original scientific article

RADIAL ARTERY ANOMALIES IN THE MACEDONIAN POPULATION DURING TRANSRADIAL ANGIOGRAPHY PROCEDURES

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Primljen/Received 13. 05. 2016. god.

Prihvaćen/Accepted 12. 06. 2016. god.

Abstract: **Objective:** To assess the incidence of arterial anomalies of the radial artery in the Macedonian population registered during transradial access (TRA) angiography procedures in a large series of patients.

Background: Transradial angiography (TRA) is now the recommended access for percutaneous coronary intervention, but technically is a more challenging approach for angiography procedures mostly due to the anatomic anomalies on the radial artery, which may influence the success rate of transradial angiographic procedures.

Methods: All consecutive 19292 patients from our Center, in the period from March 2011 until December 2014 were examined. Preprocedural radial artery angiography was performed in all patients. Clinical and procedure characteristics, type and incidence of vascular anatomy variants and access site complications were analyzed.

Results: Anatomical variants were present in 1625 (8.8%) patients. The most frequent was high-bifurcating radial artery origin from the axillary and brachial arteries in 1017 (5.5%) patients, 227 (1.2%) had extreme radial artery tortuosity, 176 (0.95%) had a full radial loop, 32 (0.17%) with hypoplastic radial artery and 173 (0.9%) had tortuous brachial, subclavian and axillary arteries. Radial artery spasm was very common in patients with present radial artery anomalies.

Conclusion: Radial artery anomalies are very common in the general population. Knowing the anatomy of the radial artery helps the interventional cardiologist in successfully planning and performing this procedure. Radial artery angiography is strongly encouraged in every patient before the begining of the transradial angiography procedures.

Keywords: TRA (Transradial artery access), RA (Radial artery), TFA (Transfemoral artery access), Vascular anatomy variants.

INTRODUCTION

Trans radial access (TRA) is now the preferred access site for percutaneous cardiovascular interventions in experienced radial centers (1).

Radial artery anomalies are frequently found in the general population. Autopsy studies of upper limbs have found arterial anatomical variations in between 4% and 18.5%, (2, 3) while arteriography studies reported percentages between 7.4% and 22.8% (4-7, 8, 9).

Multiple studies support transfer from femoral artery access to radial access for all angiographic diagnostic and interventional procedures mostly due to decreasing access site bleeding and vascular complications without sacrificing procedural success (10, 11, 12, 13). The radial approach improves patient comfort and satisfaction, allows rapid ambulation and is associated with reduced cost and hospital stay (10, 11, 12, 13).

Patients with increased risk of bleeding and vascular complications have a particular benefit from TRA as opposed to transfemoral approach (TFA): female gender, elderly, obesity, low weight, hypertension, renal failure, low platelet count and anemia (10, 11, 12, 13).

Transradial approach as opposed to transfemoral approach is a technically more challenging approach mostly due to the present radial artery anatomic anomalies, which may influence the success rate and procedure time of transradial angiographic procedures (4, 5, 6, 7). Prior studies have reported that radial arterial anomalies can influence the success of transradial access and are cause for access crossover from TRA to other access sites (4, 5, 6, 7).

It is important that interventionalists learning the transradial technique while performing angiography procedures become familiar with common anatomic

radial artery anomalies and learn how to navigate through them.

Most experienced transradial operators in high volume transradial centers can overcome these anomalies and successfully perform their procedures without prolonging procedure time.

In this study we evaluate the incidence of these variations in the Macedonian population during transradial approach angiography procedures in a large cohort of patients from a national PCI (percutaneous coronary interventions) referral center.

MATERIALS AND METHODS

Patient population

This was a prospective single center study including all patients from March 2011 to December 2014 referred for coronary or peripheral angiography to a large volume tertiary referral center at the University Clinic of Cardiology, Skopje, Macedonia.

Table 1. *Arterial access*

Clinical Variables	Total N of Patients N = 19292
TRA	18417 (95.4%)
TUA	812 (4.2%)
TFA	53 (0.3%)
TBA	10 (0.05%)

* TRA — Transradial access; TUA — transulnar access; TFA — transfemoral access; TBA — transbrachial access

All procedures were performed by experienced transradial operators (> 500 diagnostic TRA procedures and > 300 PCI procedures per year). Radial artery angiography was performed in all patients to evaluate the presence of any anatomic variation of the arteries. Total number of procedures done in that period was 19292. Transradial access was performed in 95% (18417), transulnar access with 4,2% (812), transfemoral 0,3% (53) and transbrachial access in 0,05% of all procedures (Table 1).

Radial artery puncture and cannulation

After local anesthesia with 1ml lidocaine 2%, radial artery (RA) puncture was performed with a sheath set, including a 20 gauge 2-piece needle, 0.025 inch straight wire and a 16-cm 6Fr or 5F sheath. Following sheath insertion, a drug cocktail consisting of verapamil (5mg) and heparin (3000 U) was administered through the sheath sidearm.

In case of interventional procedures weight adjusted Heparin (100 U/kg) was administered through the sheath before the start of the procedure.

Retrograde radial arteriography was performed after administration of the arterial vasodilatator to define the radial artery anatomy from mid forearm to ulnobrachial anastomosis and to delineate ulnar artery anatomy as well, generating a roadmap for the intervention. A solution of 3ml of contrast (Ultravist 370) diluted with 7 ml of blood was injected through the cannula or through the side arm of the sheath under fluoroscopy in AP position. If anomalous anatomy was identified, the operator planned the procedure on that basis. Retrograde arteriography is of particular importance when there is some resistance in guidewire advancement and in patients after previous transradial interventions. If the operator identified a possible anomaly in brachial, axillar or subclavian arteries, an arteriogram higher up the arm was obtained.

In case of radial access failure, transfer was done to ipsilateral ulnar artery or to the left radial artery or transfemoral artery depending on operator preference. Only 3 cases with anomalies required transfer to femoral access.

Post procedure management: The sheath was removed immediately after the procedure, regardless of the level of anticoagulation, and a compressive dressing or closure device was applied to the wrist. In our practice we use TR band or simple compressive dressing. In order to decrease the rate of radial artery occlusion we applied patent hemostasis by using pulse oximetry to confirm the hemoglobin oxygen saturation on the punctured radial artery (> 90%), after hemostasis was obtained (during measurement UA was compressed manually). Compression was applied for approximately a 2 to 3-hour period with gradual relaxation of compression or deflation of the TR band after the 1st hour.

Aim of study

The aim of this study was to access the incidence of radial artery anomalies in the Macedonian population. Procedural time and fluoroscopy time was analysed. Complications during the procedure as radial artery spasm and haemathoma were recorded after every procedure.

Definitions

A high bifurcating origin of the radial artery was defined as the origin of the radial artery from the brachial or axillary artery proximal to the upper border of the cubital fossa.

Radial artery loop was defined as presence of a full 360 degrees loop of the radial artery, with or without the presence of a remnant radial artery (Figure 1).

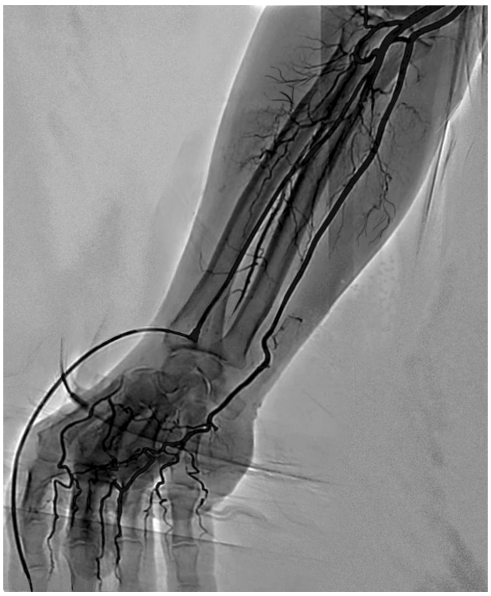

Figure 1. *Radial artery loop*

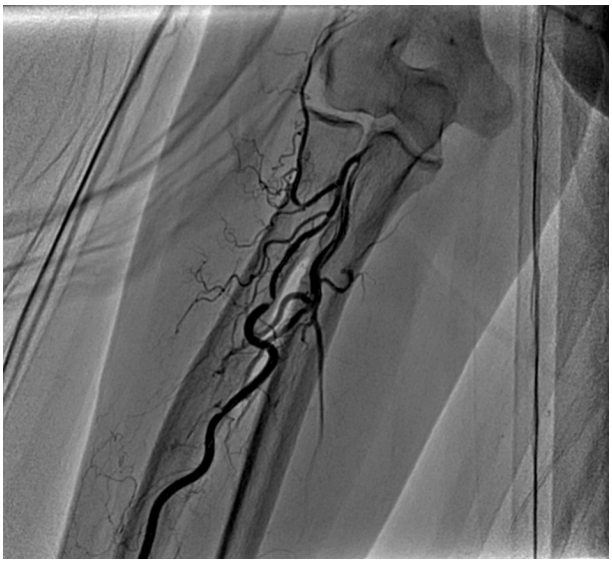

Figure 2. *Radial artery tortuosity*

Radial, brachial and subclavian artery tortuosity was defined as presence of a curve of more than 45 degrees in the vessel (Figure 2).

Clinical radial artery spasm (RAS) was classified as grade I: minimal local pain and disconfort; grade II: significant local pain and discomfort, not precluding procedure completition; grade III: severe local pain and disconfort necessiting cross over and grade IV: catheter entraptment with severe local pain and disconfort (14, 15).

Vascular access site complications were defined as the occurence of an aneurysm, fistula, hematoma, loss of radial pulse or radial nerve injury.

Hematoma was classified into five grades (grade I: local hematoma, superficial < 5 cm; grade II: hematoma with moderate muscular infiltration; grade III: forearm hematoma and muscular infiltration, below the elbow; grade IV: hematoma and muscular infiltration extending above the elbow; grade V: ischemic threat - compartment syndrome) (16).

Statistical analysis

Simple descriptive statistics was used. For normally distributed numeric variables, data was expressed as mean ± standard deviation and for continuous variables not fitting a normal distribution as median (minimum-maximum). Percentages were used to express categorical variables. Chi-square test was used to compare categorical variables and student's t-test was used to compare differences between two groups. A P-value of < 0.05 was considered statistically significant. Statistical analysis were performed with SPSS 17.0 for Windows (SPSS Inc. Chicago, ILL).

RESULTS

From 19292 consecutive transradial procedures, anatomical variants were present in 1625 (8.8%) patients. From baseline caracteristics 66% of patients with present anomalies were male, with medium BMI of 23 (19-43). Diabetes was present with 19% and hypertension with 67%. 22% of patients with STEMI (acute myocardial infarction procedures with ST segment elevation) had RA anomalies. There was no significant difference in procedure or fluoroscopy time of patients with anomalies compared to the general population.

Patients with RA anomalies in the Macedonian population had median age of 62 (27-90) higher than the median age of the general population without RA anomalies which was 52 years (18-91) (Table 2).

Table 2. *Baseline characteristics of patients with TRA*

Clinical Variables	Total N Patients (N = 18417) (95,4%)	Patients with RA anomalies (N = 1625)(8,8%)
Age (years)	52 (18-91)	62 (27-90)
Male	12750 (70%)	1076 (66%)
Female	5667 (30%)	503 (31%)
BMI (kg/m^2)	25 (19-47)	23 (19-43)
CAD risk factors		
Hypertension	13704 (74%)	1086 (66,8%)
Diabetes mellitus	4422 (24%)	312 (19,2%)
Dyslipidemia	5010 (27%)	372 (22,9%)
Smoking	5535 (30%)	453 (27,8%)
PCI	8965 (48,6%)	768 (47,2%)
CAS	2467 (13,3%)	235 (14,4%)
STEMI PCI	3495 (18,9%)	356 (22%)
Prior TRA	1-88 (min)	0-80 (min)
Fluoroscopy time	10-300 (min)	10-180 (min)
Procedure time		

* CAD — Coronary artery disease; PCI — Percutaneous coronary intervention; STEMI — ST segment elevation myocardial infarction; CAS — Carotid artery stenting

Most frequent radial artery anomaly was the high-bifurcating radial artery originating from the axillary and brachial arteries found in 1017 (5.5%) patients. Full radial loop was present in 176 (0.95%) patients and 227 (1.2%) patients had extreme radial artery tortuosity, 32 (0.17%) had hypoplastic radial artery, 173 (0.9%) had tortuous brachial, subclavian and axillary arteries, which is shown in Table 3.

Table 3. *Anatomical variants among patients with TRA*

Anatomical variants	Incidence
Total Number of patients with present anomalies	1625 (8,8%)
High bifurcating origin of the radial artery from the brachial or axillary arteries	1017 (5,5%)
Radial artery loop (360°)	176 (0,95%)
Radial artery tortuosity	227 (1,2%)
Hypoplastic radial artery	32 (0,17%)
Loop of the brachial/axillary/subclavian artery	173 (0,9%)

Table 4. *Secondary outcomes based on present RA anomalies*

	RA anomalies group N = 1625 (8,8%)	RA without anomalies N = 16790 (91,2%)	P value
Clinical radial artery spasm	206 (12,6%)	471 (2,5%)	< 0,001
Access site bleeding complications	133 (8,2%)	1290 (7, 7%)	

* RA — radial artery

Table 5. *Access site complications*

Access site complications	%
Clinical radial artery spasm	206 (12,6%)
Grade I	40/1625 = 2,5%
Grade II	84/1625 = 5,2%
Grade III	67/1625 = 4,1%
Grade IV	15/1625 = 0,9%
Access site bleeding complications	133 (8,2%)
Haemathoma grade 1	43/1625 = 2,6%
Haemathoma grade 2	56/1625 = 3,4%
Haemathoma grade 3	20/1625 = 1,2%
Haemathoma grade 4	11/1625 = 0,7%
Haemathoma grade 5	3/1625 = 0,2%
Major vascular complications	0%

* RA — Radial artery

Clinical radial artery spasm was significantly more frequent in cases with present anomalies 12%, compared to cases without present anomalies 2.5% respectively ($p < 0,001$). In 82 cases high grade IV and V clinical spasm was present (5%), which is shown in Table 4. Access site bleeding complications were similar in both groups with 8,2 and 7.7% respectively.

Haematoma grades IV and V were present in 14 cases which resolved without clinical consequences. None of the patients needed vascular repair of the puncture site, which is shown in Table 5.

DISCUSSION

We can conclude that radial artery anomalies are very common in the Macedonian population with a 8.8 percentage registered in our study in a large patient cohort. These results were analysed from the data of the the largest national center for percutaneous angiography procedures in Macedonia in the period of 4 years. Our PCI center has 98% take of all angiography procedures performed in our country. 95% of all angiography procedures in our center were performed with transradial artery access, with 4.2% using transulnar artery access. Only 0.3% of all procedures in this period were performed using transfemoral approach.

Considering the recognition given by the European cardiology panel consensus document (1) that the transradial approach should be the default approach for PCI in experienced transradial centers, it is important to understand any issues that could influence success of TRA percutaneous interventions. Even in peripheral interventions transradial approach is starting its momentum. Insufficient devices for peripheral radial artery stenting still limit its use in peripheral angiography interventions (17-23). The reported overall failure in transradial procedures is between 1% and 7% (16).

It is highly likely that radial artery anomalies influence the success of transradial agiography procedures.

Knowledge of present radial artery anomalies with pre-procedural radial artery angiography can help the interventionalist to evaluate the present anomaly and plan the angiography procedure without sacrificing procedure time or success.

We strongly encourage the use of radial artery angiography before the beginning of every transradial procedure giving the operator a chance to identify present anomalies and plan the procedure accordingly, making TRA failure less likely.

Study limitations

The definition of clinical radial artery spasm was subjective, made by presence of clinical signs. Also the hemostasis technique was not uniform.

CONCLUSION

Radial artery anomalies are very common in the general population. Knowing the anatomy of the radial

artery helps the interventional cardiologist successfully plan and perform the angiography procedure. Most of the present obstacles in TRA anomaly cases can be successfully overcome by experienced radial operators. Radial artery angiography is strongly encouraged in every patient before the begining of transradial angiography procedures.

Conflict of interest

Nothing to declare.

Source of Funding

There were no external funding source for this study.

Abbreviations

TRA — Transradial approach
RA — Radial artery
TFA — Transfemoral approach
TUA — Transulnar approach

Sažetak

ANOMALIJE RADIJALNE ARTERIJE U MAKEDONSKOJ POPULACIJI TOKOM TRANSRADIJALNIH ANGIOGRAFSKIH PROCEDURA

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Cilj: utvrditi učestalost anomalija radijalne arterije registrovanih kod makedonske populacije tokom angiografija sa transradijalnim pristupom (TRA), na velikom uzorku pacijenata.

Uvod: Transradialna angiografija (TRA) je sada preporučen pristup za perkutane koronarne intervencije, ali tehnički je još uvek više izazovan pristup za angiografiju, uglavnom zbog anatomskih anomalija na radijalnoj arteriji, što može uticati na uspešnost transradijalnih angiografskih procedura.

Metode: od marta 2011. do decembra 2014.godine, u nasem Centru pregledano je ukupno 19292 uzastopnih pacijenata. Preproceduralna radijalna angiografija je sprovedena kod svih bolesnika. Analizirane su kliničke i proceduralne karakteristike, vrsta i učestalost vaskularnih anatomskih varijanti i komplikacije.

Rezultati: Anatomske modifikacije su bile prisutne kod 1625 (8,8%) pacijenata. Većinom se radilo o visokoj-bifurkaciji radijalne arterije od aksilarne i brahijalne arterije i to kod 1017 (5,5%) pacijenata, 227 (1,2%) pacijenata je imalo izuzetnu zakrivljenost radijalne arterije, 176 (0,95%) je imalo pun radijalni luping, 32 (0,17%) je bilo sa hipoplastičnom radijalnom arterijom i 173 (0,9%) je imalo tortuozne brahijalne, subklavijalne i aksilarne arterije. Spazam radijalne arterije je bio vrlo čest kod pacijenata s prisutnim anomalijama radijalne arterije.

Zaključak: Anomalije radijalne arterije su vrlo česte u opštoj populaciji. Poznavanje anatomije radijalne arterije pomaže interventnim kardiolozima u uspešnom planiranju i izvođenju ovog postupka. Angiografija radijalne arterije se preporucuje kod svakog pacijenta pre izvođenja transradijalne angiografije.

Ključne reči: TRA (transradijalni arterijski pristup), RA (radijalna arterija), TFA (tranfemoralni arterijski pristup), vaskularne anatomske varijacije.

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