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Comparative Analysis of Transradial and Transfemoral Arterial Approach When Performing Diagnostic Coronary Angiography

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ABSTRACT

Background: The transfemoral (TF) arterial approach is still the most commonly used approach for performing diagnostic coronary angiography in most centers in the world as well as in Bosnia and Herzegovina. Recently, the transradial (TR) arterial approach has gained more and more supporters among interventional cardiologists. **Objective:** The aim of the study was to compare the duration of the procedure, the amount of delivered ionizing radiation, the amount of applied contrast agent, the frequency of procedural complications and patient comfort during coronary angiography performed via TR and TF arterial approach. **Methods:** The total sample of 240 respondents was divided into two groups in such a way that the first group consisted of 121 respondents who underwent coronary angiography using TR arterial approach, and the second group consisted of 119 respondents who underwent coronary angiography using TF arterial approach. The Mann-Whitney U test was used to verify the research objective. **Results:** The obtained research results showed that the duration of coronary angiography and the amount of radiation was greater when using TR arterial approach compared to TF approach. There is no statistically significant difference in relation to the amount of applied contrast medium and the frequency of complications between the two approaches. Periprocedural and postprocedural comfort was better in patents who underwent TR approach. **Conclusion:** The findings of this study show that diagnostic coronary angiography performed via the TR arterial approach is as safe for the patient as diagnostic coronary angiography performed via the TF arterial approach. With both approaches, there is no significant difference in the amount of contrast agent used nor in the frequency of complications. Procedure duration and radiation exposure are shorter when TF arterial approach i used, while patient comfort is better when the TR arterial approach is used.

Keywords: Coronary angiography, transradial arterial approach, transfemoral arterial approach, duration of coronary angiography, amount of radiation.

1. BACKGROUND

Coronary angiography is an invasive radiographic procedure in which a contrast agent (most often iodine) is injected through catheters placed at the ostia of the coronary arteries, which is visualized radiographically in order to detect stenosis or occlusion of the coronary arteries (1). Coronary angiography represents the gold standard in detecting significant, flow-limiting stenoses, which can be revascularized by percutaneous or surgical interventions.

The TF arterial approach is still the most commonly used approach for performing coronary angiography and percutaneous coronary interventions in most centers in the world as well as in Bosnia and Herzegovina.

Recently, the TR arterial approach has gained more and more supporters among interventional cardiologists (2) who state that this approach has certain advantages compared to the TF arterial approach, especially in patients on antiplatelet and anticoagulant therapy who have an increased risk of bleeding and other complications related to the puncture site. It is also reported that TR arterial approach is associated with shorter patient immobilization and shorter length of hospital stay (3).

2. OBJECTIVE

The aim of the study was to compare the duration of the procedure, the amount of delivered ionizing radiation, the amount of applied contrast agent, the frequency of periprocedural and postprocedural complications and patient comfort during coronary angiography performed via TR and TF arterial approach.

3. MATERIAL AND METHODS

The research involves a clinical prospective comparative study in which the TR arterial approach was compared with the TF arterial approach when performing coronary angiography with the aim of diagnosing coronary artery disease (CAD). The research was conducted at the Clinic for Invasive Cardiology of the University Clinical Center in Tuzla in the period from December 2018 to January 2020. The research included a total sample of 240 respondents, with an average chronological age of 62.60 ± 9.22, ranging from 24 to 85. Out of 240 patients, 137 (57.1%) respondents were male, and 103 (42.9%) respondents were female. Data was taken directly from the CATH lab on a Phillips ALLURA XPER FD2 machine. All procedures were performed by one operator. The total sample of 240 respondents was divided into two groups in such a way that the first group consisted of 121 respondents who underwent TR arterial approach, and the second group consisted of 119 respondents who underwent TF arterial approach.

The study included respondents with positive anamnesis and objectified high suspicion of the existence of CAD (positive at least one of the non-invasive tests for the assessment of induced myocardial ischemia) and who were indicated to undergo elective diagnostic coronary angiography. The criteria for inclusion in the study were: symptomatic patients with objectified high suspicion of the existence of CAD (positive at least one of the non-invasive tests for the assessment of induced myocardial ischemia), cardiopulmonary compensated patients, patients with satisfactorily regulated values of arterial blood pressure, heart rate and glycemia. Exclusion criteria from the study were: patients undergoing urgent coronary angiography due to suspected acute coronary syndrome, patients with previously verified generalized atherosclerosis affecting the arteries of the extremities or the aorta, patients with acute or chronic kidney disease, patients with coagulation disorders (coagulopathy) and /or patients who were on oral anticoagulant therapy, patients who underwent percutaneous coronary intervention in the same hospitalization after diagnostic coronary angiography, patients who previously underwent surgical revascularization of the myocardium, patients undergoing hemodialysis with A-V fistulas.

All punctures at the access points (radial artery and common femoral artery) were performed after manual palpation, without using ultrasound guidance. During coronary angiography performed by any approach, four standard projections were used when visualizing the left coronary artery, and in case of need for better visualization of certain segments of the arteries, one or two additional projections were made. Two standard projections were used for imaging the right coronary artery, and in case of need for better visualization, one more additional projection was made. When using the TR arterial approach, the patient was administered Heparin 5000 IU before the procedure, and immediately after the procedure, the arterial introducer was removed and hemostasis was performed with an adequate bracelet (Terumo TR Band 18 ml), which was usually worn for 4 hours.

When using the TF arterial approach, immediately after the procedure, the arterial introducer was removed and manual hemostasis was performed for 5 to 10 minutes. Then, one or two sandbags weighing 1.5 kg were placed and kept for 6 hours after the removal of the arterial introducer while the patient was in the supine position.

During each diagnostic coronary angiography, the duration of the procedure (in minutes), the amount of applied contrast agent (in milliliters) and the amount of delivered ionizing radiation during the procedure (in mGy), the frequency of various periprocedural and postprocedural complications were measured. Periprocedural and postprocedural patient comfort was measured through a specially designed questionnaire.

The periprocedural and postprocedural complications we monitored were: impossibility of securing the arterial access (puncture/placement of arterial introducer), vagal response during or after the procedure, allergic reaction during the procedure, dissection and/or rupture of the access artery (femoral/radial), dissection of the aorta and/or its large branches, dissection and/or rupture of coronary artery, air embolism, myocardial infarction during the procedure (of any cause), occurrence of arrhythmias during the procedure (ventricular tachyardia/ventricular fibrillation, supraventricular arrhythmias, bradycardia, conduction disturbances), major hematoma or bleeding at the puncture site, occlusion or thrombosis of the access artery (loss of pulse after the procedure), pseudoaneurysm at the puncture site, AV fistula at the puncture site, stroke and transient ischemic attack (cerebrovascular complications), contrast induced nephropathy and death of the patient.

We used a specially designed questionnaire for assessment of periprocedural and postprocedural patient comfort. Seven procedure-specific questions were used in this questionnaire. We asked the patient to rate their discomfort on a numerical scale from 0 to 5 in relation to different parts of the periprocedural and postprocedural period. It was explained to the patients that 0 represents a complete lack of discomfort and 5 represents the greatest discomfort they can imagine. Five of the questions included were related to arterial access: compression after removal of the arterial introducer (referring to the amount of discomfort caused by compression), loss of "feeling" in the extremity that was punctured, soreness at the puncture site, sensation of a foreign body at the puncture site, bleeding or hematoma at the puncture site. The remaining two issues: length of immobilization after the procedure and pain in the spine or lower back after the procedure were associated with reduced patient mobility.

Variables	M	SE	MED	MOD	SD	SK	KU	MIN	MAX
Age	62,60	0,60	64	70	9,23	-0,73	0,87	24	85
Total duration of the procedure	11,26	0,27	10,55	10.55	4,23	1,55	3,85	4,58	32,19
Amount of applied contrast agent	79,52	1,54	80,00	100,00	23,85	0,58	0,59	40,00	180,00
Amount of delivered radiation	217,07	5,40	205,63	110.11	83,61	0,75	0,34	87,42	502,11

Table 1. Measuremenst of central tendency and measurements of dispersion in relation to observed variables

Variables	M	SE	MED	MOD	SD	SK	KU	MIN	MAX
Compression after removal of the arterial introducer	2,78	0,07	3,00	2,00	1,03	0,27	-0,55	1,00	5,00
Loss of "feeling" in the extremity that was punctured	1,52	0,05	1,00	1,00	0,71	1,28	1,18	1,00	5,00
Sensation of the presence of a foreign body at the puncture site	1,28	0,04	1,00	1,00	0,56	2,09	3,99	1,00	5,00
Length of immobilization after the procedure	2,75	0,09	3,00	1,00	1,44	0,21	-1,34	1,00	5,00
Soreness at the puncture site	2,31	0,07	2,00	2,00	1,03	0,57	-0,30	1,00	5,00
Pain in the spine/lower back after the procedure	2,17	0,08	2,00	1,00	1,27	0,84	-0,45	1,00	5,00
Bleeding/hematoma at the puncture site	1,59	0,05	1,00	1,00	0,81	2,07	5,87	1,00	5,00
Total score	14,43	0,33	13,00	11,00	5,04	0,78	-0,04	7,00	30

Table 2. Measuremenst of central tendency and measurements of dispersion in questionnaire related to periprocedural and postprocedural patient comfort

Variables	Arterial approach used	Average rank	Sum of ranks	M-W	Z	p
Duration of coronary angiography	Transradial	139.62	16894.50	4885.50	-4.30	.000
	Transfemoral	101.05	12025.50			
Amount of applied contrast agent	Transradial	122.35	14804.50	6975.50	-.42	.673
	Transfemoral	118.62	14115.50			
Amount of radiation	Transradial	149.98	18148.00	3632.00	-6.63	.000
	Transfemoral	90.52	10772.00			
Amount of radiation	Transradial	116.92	13913.00	6773.00	.90	.363
	Transfemoral	120.11	14053.00			

Table 3. Results of the Mann-Whitney U test (M-W)

Statistical analysis

The research data was processed using the method of parametric and non-parametric statistics. The basic statistical parameters of the measure of central tendency, measure of dispersion were calculated, and the obtained results were presented in a table.

Arithmetic mean, median and mode were calculated from measures of central tendency, and standard deviation, minimum and maximum results from measures of dispersion. The Mann-Whitney U test was used to verify the research objective. Research data was processed in the statistical package SPSS 20 for Windows.

4. RESULTS

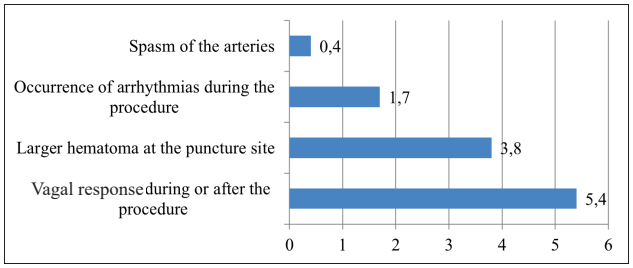
The results in the Table 1 show that the chronological age of the respondents is 62.60±9.23 years. The minimum and maximum age ranges from 24 to 85 years. The average total duration of the procedure was 11.26 ± 4.23 minutes. The minimum and maximum duration of the procedure ranges from 4.58 to 32.19 minutes. The average amount of delivered radiation was 217.07 ± 83.61 mGy, the minimum is 87.42 mGy, and the maximum is 502.11 mGy. The average amount of applied contrast agent is 79.52 ± 23.85 ml, while the minimum and maximum amount ranges from 40 – 180ml.

Table 2 shows measures of central tendency and measures of dispersion of respondents in relation to the results of a specially designed questionnaire for periprocedural and postprocedural patient comfort. Given that the questionnaire for patient periprocedural and postprocedural comfort consists of 7 assessment variables, it was transformed in such a way that the responses to the statements were added up, resulting in a total score that ranges from 7 to 35. A lower number of points indicates the absence, and a higher number of points for the presence of discomfort or pain in various procedural and postprocedural aspects. The average value on the patient comfort questionnaire is 14.43 ± 5.04, median and mode 13 and 11, while the minimum and maximum scores range from 7 to 30.

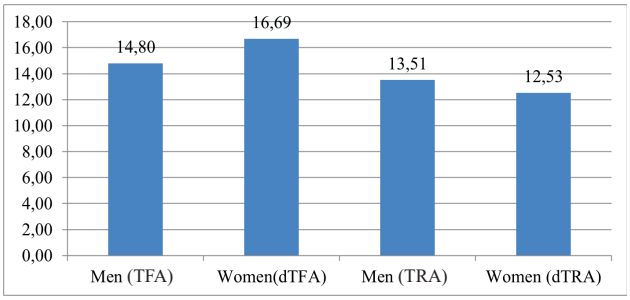
Table 3 shows the results of the Mann-Whitney U test. Based on the obtained results shown in table 2, it can be concluded that at the level of statistical significance 0.01, the duration of coronary angiography is longer in patients who underwent a TR compared to a TF arterial approach. The results showed that in relation to the amount of applied contrast agent, there is no statistically significant difference between patients who underwent diagnostic coronary angiography using TR and TF arterial approach. The amount of delivered ionizing radiation during coronary angiography at the level of statistical significance of 0.01 is higher in patients who underwent the TR arterial approach compared to the TF approach. Also, it can be concluded that at the 0.01 level of statistical significance periprocedural and postprocedural comfort of the patient is better when using TR arterial approach.

Arterial approach		Complications		Total
		Yes	No	
Transradial	N	8	113	121
	%	6.6%	93.4%	100.0%
Transfemoral	N	8	111	119
	%	6.7%	93.3%	100.0%
Total	N	16	224	240
	%	6.7%	93.3%	100.0%

Table 4. Frequency of occurrence of complications in relation to the used arterial approach x2 = 0,01; p = 0,972



Graph 1. Distribution of respondents in relation to periprocedural and postprocedural complications



Graph 2. Periprocedural and postprocedural comfort of coronary angiography (by gender)

Graph 1 shows the distribution of respondents in relation to periprocedural and postprocedural complications. Of the 240 respondents included in the research, complications were observed in 16 respondents. The largest percentage of respondents had a vagal response during or after the procedure (5.4%). A larger hematoma (> 5cm) at the puncture site was recorded in 3.8% of respondents, while the occurrence of arrhythmias during the procedure was recorded in 1.7% of respondents. An artery spasm was recorded in one respondent. It is important to note that there were no serious complications that resulted in permanent patient morbidity or mortality.

The obtained results shown in Table 4 indicate that complications were recorded in 6.6% of respondents treated with a TR approach and in 6.7% of respondents treated with a TF approach. The results of the chi-square test (x2 = 0.01; p = 0.972) showed that, in relation to the frequency of complications, there is no statistically significant difference between respondents who underwent TR and TF arterial approach. By analyzing the odds ratio, it can be concluded that there is no difference in the risk of complications of diagnostic coronary angiography in respondents using TR and TF.

Graph 2 shows the average periprocedural and postprocedural comfort in patients who underwent coronary angiography via TR and TF arterial access in relation to gender. The obtained results in Graph 2 show that the best average periprocedural and postprocedural comfort is in female subjects treated with TR arterial access (12.53), while the worst is also in female subjects but treated with TF arterial access (16.69). Average periprocedural and postprocedural comfort in male subjects treated with the TF approach is 14.80.

5. DISCUSSION

What sets our research apart from others that followed similar parameters is the fact that we followed patients who were exclusively undergoing elective diagnostic coronary angiography. Patients who underwent emergency coronary angiography due to suspected acute coronary syndrome were not included in the study, nor were patients who underwent percutaneous coronary intervention after elective coronary angiography.

The duration of the coronary angiography procedure using the TR arterial approach (12.10 min) was longer compared to the TF arterial approach (10.39 min). The TR arterial approach is technically more demanding to perform, which is especially related to the learning curve. Similarly designed randomized studies confirm these results (4), with some of them comparing the duration of diagnostic coronary angiograms as well as coronary angiograms that continue into percutaneous coronary intervention (5).

There was no significant difference in the amount of applied contrast medium between TR and TF arterial approach when performing diagnostic coronary angiography (79.91 vs 79.11 ml). Similar results have been shown in previous studies (6, 7). Our research showed that despite the longer duration of the procedure and the larger amount of delivered ionizing radiation, no more contrast agent was applied in the TR arterial approach. We conclude that the longer duration of the procedure and the larger amount of ionizing radiation delivered during the TR arterial approach are related to the more demanding technical aspect of the procedure, and the contrast agent was not used to a significant extent to overcome it. These results are significant in the context of assessment of arterial approach for patients with an increased risk of developing contrast induced nephropathy.

The amount of delivered ionizing radiation was higher with the TR arterial approach compared to the transfemoral arterial approach (250.6 vs 182.9 mGy). A large meta-analysis of nearly 20,000 patients from 2015. shows that TR arterial approach is associated with a small but significant increase in ionizing radiation exposure compared to TF arterial approach (8). The same study also shows that the difference in radiation exposure decreases from year to year, which is probably related to the increase in the number of procedures due to greater acceptance of the TR arterial approach, but also to technological progress. However, some of the studies do not correlate with these findings and show that there

is no difference in the time of fluoroscopy and exposure to ionizing radiation (6, 7). One study involving centers using high-volume TR arterial approach shows that with adequate use of radiation protection techniques, TR arterial approach may be associated with lower patient exposure to ionizing radiation (9). The evidence so far is in favor of the fact that the current exposure to ionizing radiation is greater when using TR arterial approach, but that with greater acceptance of this approach in certain centers, technical progress in the equipment used and the use of radiation protection measures, the amount of ionizing radiation can be significantly reduced in favor of TR arterial approach.

There was no significant difference in periprocedural and postprocedural complications in patients who underwent diagnostic coronary angiography using TR and TF arterial approach (6.6% vs 6.7%). The largest percentage of respondents had a vagal response during or after the procedure (5.4%). A larger hematoma at the puncture site was recorded in 3.8% of respondents, while the occurrence of arrhythmias during the procedure was recorded in 1.7% of respondents. An artery spasm was recorded in one respondent. It is important to note that there were no serious complications that resulted in permanent patient morbidity or mortality. Previous studies have mainly compared complications between the two arterial approaches in patients with acute myocardial infarction or those in cardiogenic shock, where TR arterial approach was associated with a lower risk of all-cause mortality, major bleeding, and vascular complications compared with TF arterial approach (10).

In our study, patient comfort was better in patients who underwent diagnostic coronary angiography using TR arterial approach compared to TF arterial approach. We supported this with a specially designed questionnaire. These results are fully correlated with previous research that shows that the patient's comfort, including the hospital length of stay, is better in patients who underwent TR with arterial access (11, 12).

6. CONCLUSION

The findings of this study show that diagnostic coronary angiography performed via TR arterial approach is as safe for the patient as diagnostic coronary angiography performed via TF arterial approach. With both arterial approaches, there is no significant difference in the amount of contrast agent used nor in the frequency of periprocedural and postprocedural complications. Procedure duration and radiation exposure are shorter when the TF arterial approach is used, while patient comfort is better when the TR arterial approach is used.

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