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ORIGINAL RESEARCH

Incidence Rate and Risk Factors of Radial Artery Spasm during Transradial Coronary Angiography

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Abstract: **Background:** Radial artery spasm (RAS) is one of the most common complications of radial coronary angiography. Several demographic and clinical factors increase the risk of RAS in this procedure. We aimed to evaluate the effect of various risk factors on the incidence and severity of RAS in radial coronary angiography. **Methods:** This cross-sectional study was performed on 120 patients who were randomly selected from candidates referred to Shahid Modarres Educational Medical Center for coronary angiography by the radial method. After angiography, radial arteriography was performed to diagnose spasms. The association of some demographic and clinical factors with the incidence and severity of RAS was evaluated. **Results:** 35 of the 120 patients (29.16%) developed RAS during angiography. Shorter height, shorter radius bone length, less radial artery diameter, longer procedure length, diabetes mellitus, more catheters used, and female sex were significantly associated with higher incidence. The predictive power of these factors for the occurrence of spasms was very good with AUC=0.88. Age, shorter height, higher body mass index, smaller radial artery diameter, longer procedure time, diabetes mellitus, failure of initial effort for puncture, number of catheters used, and female sex were significantly associated with the severity of spasms. **Conclusion:** The incidence or severity of spasms during the procedure can be reduced by examining the available risk factors for every patient before deciding to perform angiography.

Keywords: Coronary angiography, Incidence, Radial artery spasm, Risk factors

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1. Introduction

Coronary heart disease is one of the most common causes of death and disability in developed countries. It is thought to cause one-third of deaths in people over the age of 30 (1). There are various diagnostic methods to detect cardiovascular disease, which are adopted according to the patient's symptoms and condition and the physician's opinion. Currently, coronary angiography is considered as the standard diagnostic method to understand the anatomy, physiology, hemodynamics of the heart and coronary arteries. Usually, two types of vessels are used to access the arteries, and femoral or radial vessel (TRA) (2). In people with abdominal aortic, iliac, and femoral artery disease, or in people who are severely obese or have highly curved arteries, the femoral artery cannot be accessed. Today, radial angiography has received a lot of attention from physicians and patients and is the first choice for access to arteries in many centers around the world (3). This method has become very popular because of benefits such as fewer complications, less bleeding due to the lack of vascular structures and major nerves around the radial artery, and dual vascular nutrition through the radial and ulnar arteries, less patient pain, reduced the risk of infection at the site of vascular access, reduced hospitalization days, cost reduction, earlier mobility, and patient satisfaction (4-6).

Radial artery spasm (RAS) has always been considered as a common complication during radial angiography, either selectively or urgently, which can lead to severe pain in the patient and even failure of the angiography process (7, 8). Obstruction, perforation, and formation of radial artery hematoma are among the rarer complications of radial angiography (9). The incidence of radial spasm varies accord-

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ing to different studies and depends on various factors such as sheath or catheter type, drug composition, study population, how spasm is defined, and the operator expertise. In previous studies, the incidence of RAS has been reported to be about 6.8-30% (10-12). However, in a low percentage of patients, coronary angiography is performed radially and in other cases, the femoral method is used. Because this method has a lower success rate, and if this method is not successful, coronary angiography should be performed again using the femoral method (13).

Studies have shown that various factors including age, sex, body mass index (BMI), diabetes mellitus, radial artery diameter, the existence of fixed atherosclerotic plaque, larger arterial sheath, longer procedure, number of catheters used, and access at first attempt determine the incidence of RAS (11, 14-16). Therefore, it seems that estimating the risk of spasm in each patient undergoing angiography and deciding on the procedure or even the use of preventive methods such as vasodilatory medications based on estimated risk will be helpful and will prevent the complications of RAS. Although many studies have been performed on the association of demographic and clinical factors with the occurrence of spasm, this study is conducted for the first time in Iran. Demographic factors differ between different countries, which may lead to differences in research results. In this study, we also examined the relationship between radius length (from styloid process to olecranon process) with the incidence of RAS for the first time.

2. Methods

2.1. Patients

This cross-sectional study consisted of 120 patients who were candidates for coronary angiography by the radial method in Shahid Modares Center during 2017-2020. These 120 patients were selected by simple random sampling. To select individuals, first, a complete description of the study was given to each patient and after signing the informed consent the patient was enrolled. A brief history of demographic characteristics such as age, sex, height, weight, BMI, high blood pressure, tobacco use, and diabetes mellitus was taken from each patient. then the patient underwent angiography. Heparin and nitroglycerin solution was used for all patients to prevent spasm. One of the hospital cardiologists performed all angiographies for patients enrolled in this study. Radial arteriography was performed at the end of the angiography procedure. In radial arteriography, 5-10 ml of contrast agent was injected in the radial artery to determine the incidence of spasm. For patients with GFR less than 60, arteriography was not performed because of increased risk of nephrotoxicity because of excess contrast agent. The observation of radial artery narrowing more than 50% compared to the intact segment of the vessel in angiographies defined as RAS. Radius bone length and size were determined by surface anatomy.

2.2. Classifying patients for comparison

After radial angiography, 35 out of 120 cases were classified in the category of patients with RAS according to diagnostic criteria for radial spasms by an angiographer. In the second part of the study, patients with spasms were divided into four groups: the first group of patients had one spasm, the second group had two, the third group had three and the fourth group had four radial spasms. Then, the patients were evaluated for the incidence and severity of spasm with demographic, clinical, and technical angiographic parameters such as age, sex, diabetes mellitus, blood pressure, BMI, radius bone length, number of catheters used, duration of the procedure, and first puncture attempt. Demographic and clinical characteristics of the patients in different groups are shown in Table 1.

2.3. Statistical analysis

Adherence of quantitative parameters including age, weight, height, BMI, radius bone length, radial artery diameter, procedure duration to a normal distribution, was assessed using the Kolmogorov-Smirnov test. The association of these with spasms incidence in the presence of normal distribution was analyzed by t test and in the absence of normal distribution by the Mann-Whitney test. The association of quantitative data with spasms severity in case of normal distribution were evaluated by one-way ANOVA test and in the case of non-compliance with normal distribution were analyzed by Kruskal-Wallis test. We used the post-hoc test for group comparisons with significant ANOVA. The association of qualitative parameters including sex, tobacco use, high blood pressure, diabetes mellitus, first puncture attempt, number of catheters with spasms incidence was evaluated by Fisher's exact test. Their association with spasms severity was analyzed by Chi-square test. Also, a ROC curve was drawn to evaluate the diagnostic value of the factors in predicting spasm. All statistical analyzes were performed in GraphPad Prism software, version 8, and graphs related to statistical analyzes were drawn by this software.

3. Results

3.1. Association of spasm incidence with the patients' demographic and clinical factors

In this part of the study, the incidence of spasm was compared with demographic and clinical factors of the patients in two groups of patients with spasms (35 patients) and patients who did not have spasms after radial angiography (85 patients). Based on the results of this part of the study, shorter height (P=0.001), shorter radius bone length

(P=0.001), less radial artery diameter (P<0.0001), longer procedure length (P<0.0001), diabetes mellitus (P=0.001, OR=2.66, 95% CI=1.470 to 4.954), more number of catheters (P=0.003, OR=2.46, 95% CI=1.413 to 3.996), and female sex (P=0.007, OR=2.25, 95% CI=1.285 to 3.973) were associated with the incidence of spasm in the patients. Other factors including age, weight, BMI, tobacco use, high blood pressure, and first puncture attempt were not associated with the incidence of spasm. The graphs for quantitative data analysis in this part of the study are shown in Figure 1.

3.2. ROC curve analysis

The predictive power of the patients' demographic and clinical factors in spasm occurrence was estimated by ROC curve analysis. With AUC=0.88 and P<0.001 (sensitivity = 91.43 and specificity =72.94), these factors in total can be considered as a good and acceptable predictor for radial spasm (Figure 2).

3.3. Association of spasm severity with the patients' demographic and clinical factors

In this part of the study, the association of spasm severity (none, one, two, three, or four spasms) with demographic and clinical factors of the patients was evaluated. The results showed that older age (P=0.001), shorter height (P=0.003), higher BMI (P=0.003), shorter radial artery diameter (P<0.0001), increased procedure time (P<0.0001), diabetes mellitus (P=0.0004), failure of the first puncture (P=0.03), increased number of catheters used (P=0.03), and female sex (P=0.001) were associated with increased severity of the spasm. The results also showed that the patient's radius bone length, tobacco use, weight, and blood pressure were not significantly associated with spasm severity. The graphs for the quantitative variables are shown separately in Figure 3.

3.4. Post hoc tests

In cases where the results of the ANOVA test were significant in comparison groups with different severity spasms, post-hoc tests were used. The results these tests for various parameters are shown in Table 2.

4. Discussion

In this study, 120 patients underwent radial angiography, of which 35 (29.16%) developed RAS during angiography, 10 (8.33%) had one spasm, 12 (10%) had two spasms, 6 (5%) had three spasms and 7 (5.83%) had four spasms and in 85 patients no spasm symptoms were observed. According to studies conducted in different countries with different populations and diagnostic criteria, the incidence of radial spasm ranges from 6.8% to 30% (10-12). According to the statistics obtained in the present study, it seems that radial spasm has a relatively high prevalence in Iran and deserves more attention to identify people at higher risk and through preventive actions before and during the angiography procedure to reduce the risk of radial spasm in these people or adopt another method for angiography.

In the present study, we examined the association of various demographic and clinical factors such as age, weight, height, BMI, radius bone length, radial artery diameter, procedure duration, blood pressure, diabetes mellitus, first puncture attempt, number of catheters used, and sex with the incidence and severity of RAS. We concluded that some factors such as shorter height, shorter radius bone length, shorter radial artery diameter, increased procedure duration, diabetes mellitus, use of two catheters instead of one, and female sex had a significant association with RAS incidence and the survey of these factors provided a good predictor for spasm in the patients. In the second part of the study, by examining the mentioned factors and comparing the groups with different spasm severity, we concluded that increasing age, shorter height, higher body mass index, shorter radius bone length, smaller radial artery diameter, longer procedure time, diabetes mellitus, the failure of the first puncture attempt, the greater number of catheters used, and female sex were significantly associated with an increase in spasm severity. Many studies have been done on the relationship between these factors and RAS (11, 14-16). However, the strength of our study was that we investigated the relationship between demographic and clinical factors with severity of spasm in addition to its occurrence.

In a study of 723 patients undergoing transradial angiography, it was observed that short height (P=0.047) and procedure duration (P<0.001) were associated with the incidence of radial spasm and catheter entrapment. However, unlike our study, in the mentioned study, no significant relationship was found between spasm incidence and sex or diabetes mellitus (17). The difference in results may be attributed to the much lower spasm incidence rate in this study (0.8%).

In our study, there was no significant association between age and the incidence of spasm. Studies with conflicting results have been published in this regard (18, 19). In one study, among the demographic factors, only old age was associated with spasms (19). In another study, in contrast, younger age was associated with spasms (18). Therefore, it seems that age is not an independent risk factor associated with the occurrence of spasm and is completely dependent on other accompanying factors in the patient.

About the diameter of the radial artery, a study has been performed consistent with our study, according to which the diameter of the radial artery was known as an independent factor in the incidence of radial spasm. And the smaller catheters can reduce the risk of spasms and even subsequent damage to smaller diameter arteries (20).

Numerous studies, including a study consisting of 3 cohort studies on patients' predisposing factors for the spasm, have shown that some factors, such as BMI, height, Smoking, hypertension, and peripheral arterial disease, increase the risk of spasm (16, 21, 22). Diabetes as one of the important risk factors for spasms occurred in 60% of people with high BMI in this study. This coexistence of these risk factors could be a reason for biasing results. It should be noted that other independent risk factors were not significantly different in comparison with people with high BMI and BMI in the range of health. The obvious point in other studies has been the effect of gender on the success rate of the procedure and the incidence of spasms (11, 23, 24). Considering the results of other studies, in the present study gender was identified as an important independent risk factor for both the incidence and severity of spasms.

Regarding variables during angiography, it was shown that the number of attempts for puncture and catheter size is an independent variable for the occurrence of RAS (11, 25). As mentioned in our study, the number of attempts to perform a puncture did not show a significant relationship with the incidence of spasm but instead affected the severity of the spasm. It is hypothesized that after the onset of cascading spasm events, which are directly related to more puncture efforts, these two increased the incidence of the other. However, in people who are considered low-risk patients in terms of other risk factors, even increasing the number of puncture attempts is not an independent risk factor and can not increase the incidence of RAS, alone. According to the results of the present study, age had no significant relationship with the incidence of RAS, while the severity of spasm had a significant association with age. In this case, it seems that age as an independent risk factor can not affect the incidence of spasm, while in older people due to other risk factors such as diabetes and high blood pressure if a spasm occurs, it will occur with more intensity. Because in the present study, the rate of diabetes mellitus and high blood pressure in older people was significantly higher than in younger people.

In this study, the association between the incidence of spasm with the length of the radius bone was also investigated. To the best of our knowledge, no other study has been performed on the association of this factor with radial spasm.

5. Conclusion

In summary, our results showed that many of the clinical and demographical characteristics of angiographt candidates had significant associations with both incidence rate and severity of RAS. Therefore, it could be suggested that the evaluation of these factors in these patients could be helpful in the selection of the best angiographic approach and deciding for the use of preventive methods and finally reduces the burden on the patients and health care system. For making one good easy criteria there is a need for comprehensive research with a larger sample size and wider age range and more pieces of evidence from different countries.

6. Appendix

6.1. Acknowledgment

We would like to express our gratitude to the staff of Shahid Moddares Hospital.

6.2. Conflict of interest

None.

6.3. Funding support

None.

6.4. Author's contributions

The conception and design of the work also analysis and interpretation of data by MA; MP and MAM performed angiographies and provided the patients clinical information; All the authors approved the final version to be published.

References

1. Rosamond W, Flegal K, Furie K, Go A, Greenlund K, Haase N, et al. Heart disease and stroke statistics–2008 update: a report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Circulation. 2008 Jan 29;117(4):e25-146.

2. Mizuguchi Y, Izumikawa T, Hashimoto S, Yamada T, Taniguchi N, Nakajima S, et al. Efficacy and safety of the distal transradial approach in coronary angiography and percutaneous coronary intervention: a Japanese multicenter experience. Cardiovascular intervention and therapeutics. 2020 Apr;35(2):162-7.

3. Anjum I, Khan MA, Aadil M, Faraz A, Farooqui M, Hashmi A. Transradial vs. Transfemoral Approach in Cardiac Catheterization: A Literature Review. Cureus. 2017 Jun 3;9(6):e1309.

4. Bertrand OF, Bélisle P, Joyal D, Costerousse O, Rao SV, Jolly SS, et al. Comparison of transradial and femoral approaches for percutaneous coronary interventions: a systematic review and hierarchical Bayesian meta-analysis. American heart journal. 2012 Apr;163(4):632-48.

5. Goicolea Ruigómez FJ, Ocaranza Sánchez R. [Transradial approach for primary angioplasty. Necessity or tightrope walking?]. Revista espanola de cardiologia. 2004 Aug;57(8):720-1.

6. Jolly SS, Yusuf S, Cairns J, Niemelä K, Xavier D, Widimsky P, et al. Radial versus femoral access for coronary angiography and intervention in patients with acute coro-

nary syndromes (RIVAL): a randomised, parallel group, multicentre trial. Lancet (London, England). 2011 Apr 23;377(9775):1409-20.
7. Avdikos G, Karatasakis A, Tsoumeleas A, Lazaris E, Ziakas A, Koutouzis M. Radial artery occlusion after transradial coronary catheterization. Cardiovascular diagnosis and therapy. 2017 Jun;7(3):305-16.
8. Sadaka MA, Etman W, Ahmed W, Kandil S, Eltahan S. Incidence and predictors of radial artery occlusion after transradial coronary catheterization. The Egyptian heart journal : (EHJ) : official bulletin of the Egyptian Society of Cardiology. 2019 Sep 5;71(1):12.
9. Bazemore E, Mann JT, 3rd. Problems and complications of the transradial approach for coronary interventions: a review. The Journal of invasive cardiology. 2005 Mar;17(3):156-9.
10. Gorgulu S, Norgaz T, Karaahmet T, Dagdelen S. Incidence and predictors of radial artery spasm at the beginning of a transradial coronary procedure. Journal of interventional cardiology. 2013 Apr;26(2):208-13.
11. Jia DA, Zhou YJ, Shi DM, Liu YY, Wang JL, Liu XL, et al. Incidence and predictors of radial artery spasm during transradial coronary angiography and intervention. Chinese medical journal. 2010 Apr 5;123(7):843-7.
12. Kristić I, Lukenda J. Radial artery spasm during transradial coronary procedures. The Journal of invasive cardiology. 2011 Dec;23(12):527-31.
13. Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-Ducci C, Bueno H, et al. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: The Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). European heart journal. 2018 Jan 7;39(2):119-77.
14. Ho HH, Jafary FH, Ong PJ. Radial artery spasm during transradial cardiac catheterization and percutaneous coronary intervention: incidence, predisposing factors, prevention, and management. Cardiovascular Revascularization Medicine. 2012 2012/05/01/;13(3):193-5.
15. Sandoval Y, Bell MR, Gulati R. Transradial Artery Access Complications. Circulation Cardiovascular interventions. 2019 Nov;12(11):e007386.
16. Tuncez A, Kaya Z, Aras D, Yıldız A, Gül EE, Tekinalp M, et al. Incidence and predictors of radial artery occlusion associated transradial catheterization. International journal of medical sciences. 2013;10(12):1715-9.
17. Zencirci E, Değirmencioğlu A. Catheter entrapment due to severe radial artery spasm during transradial approach. Cardiology journal. 2016;23(3):324-32.
18. Deftereos S, Giannopoulos G, Kossyvakis C, Driva M, Kaoukis A, Raisakis K, et al. Radial artery flow-mediated dilation predicts arterial spasm during transradial coronary interventions. Catheterization and cardiovascular interventions : official journal of the Society for Cardiac Angiography & Interventions. 2011 Apr 1;77(5):649-54.
19. Ruiz-Salmerón RJ, Mora R, Vélez-Gimón M, Ortiz J, Fernández C, Vidal B, et al. [Radial artery spasm in transradial cardiac catheterization. Assessment of factors related to its occurrence, and of its consequences during follow-up]. Revista espanola de cardiologia. 2005 May;58(5):504-11.
20. Saito S, Ikei H, Hosokawa G, Tanaka S. Influence of the ratio between radial artery inner diameter and sheath outer diameter on radial artery flow after transradial coronary intervention. Catheterization and cardiovascular interventions : official journal of the Society for Cardiac Angiography & Interventions. 1999 Feb;46(2):173-8.
21. Giannopoulos G, Raisakis K, Synetos A, Davlouros P, Hahalis G, Alexopoulos D, et al. A predictive score of radial artery spasm in patients undergoing transradial percutaneous coronary intervention. International journal of cardiology. 2015 Jun 1;188:76-80. 22. Khan MZ, Patel K, Franklin S, Faruqi A, Ahmad W, Saeed J. Radial artery spasm: reviews and updates. Irish journal of medical science. 2020 Nov;189(4):1253-8.
23. Gul B, Stolar M, Stair B, Hermany P, Willis S, Mena-Hurtado C, et al. Comparison of procedural success between two radial sheaths : Comparison of the 6-Fr Glidesheath Slender to 6-Fr standard sheath. Herz. 2020 Feb;45(1):79-85.
24. Sharma S, Bansal S, Isser HS, Ansari AH, Gupta P, Chakraborty P. Incidence and predictors of radial artery spasm in transradial coronary angiography. Indian Heart Journal. 2015 2015/12/01/;67:S61.
25. Hamadto M, Shafi Tabl M, Elnagar A, Attia A, Rabbat K. Prevalence and predictors of radial artery spasm associated with transradial coronary angiography and stenting. Med J Cairo Univ. 2016;84:65-73.

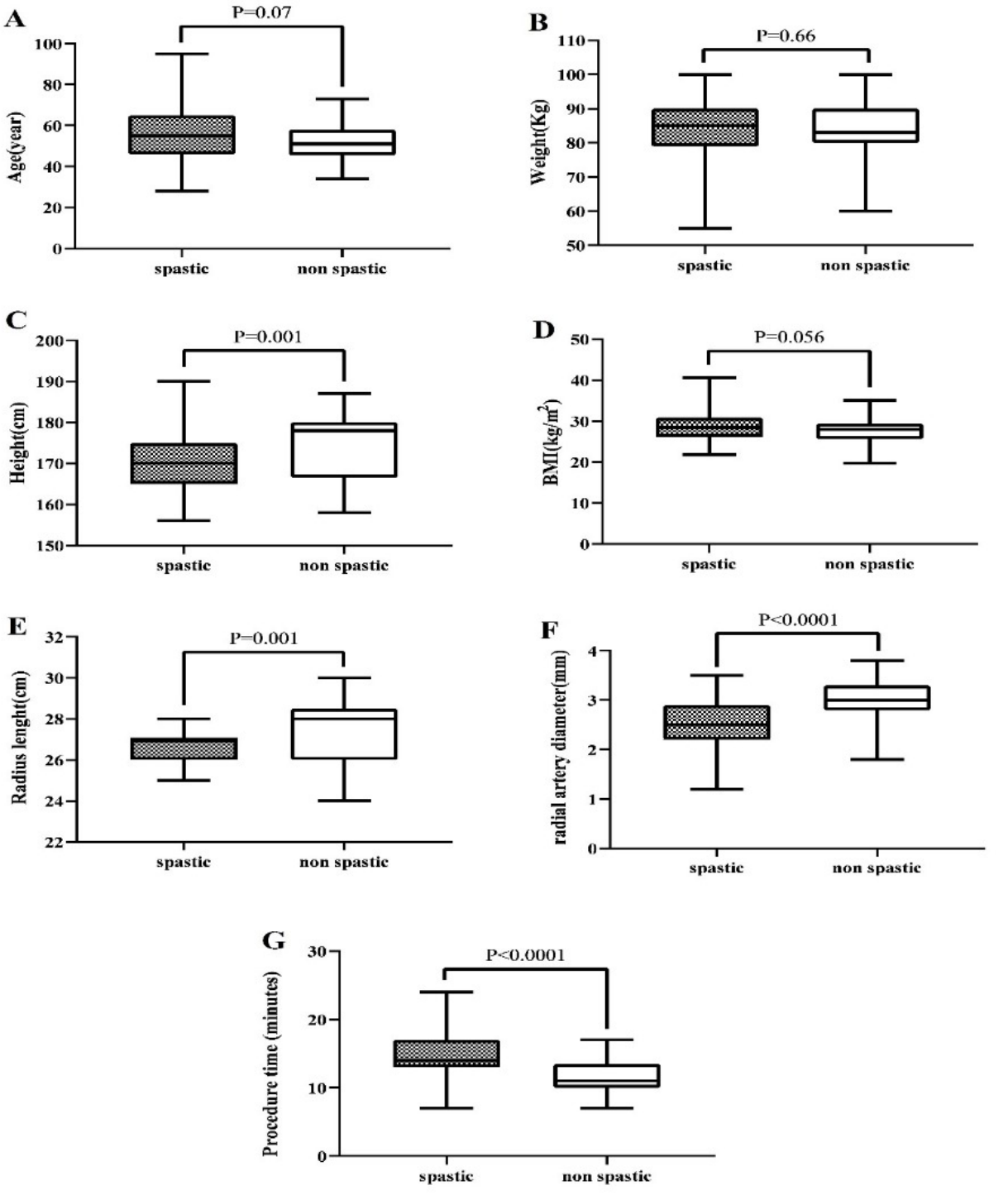

Figure 1: Evaluation of the association of spasm incidence with A) Age, B)Weight, C) Height, D) BMI, E) Radius length, F) Radial artery diameter and, G) Procedure time. Results are presented in Mean ± SEM. p-value less than 0.05 is considered significant.

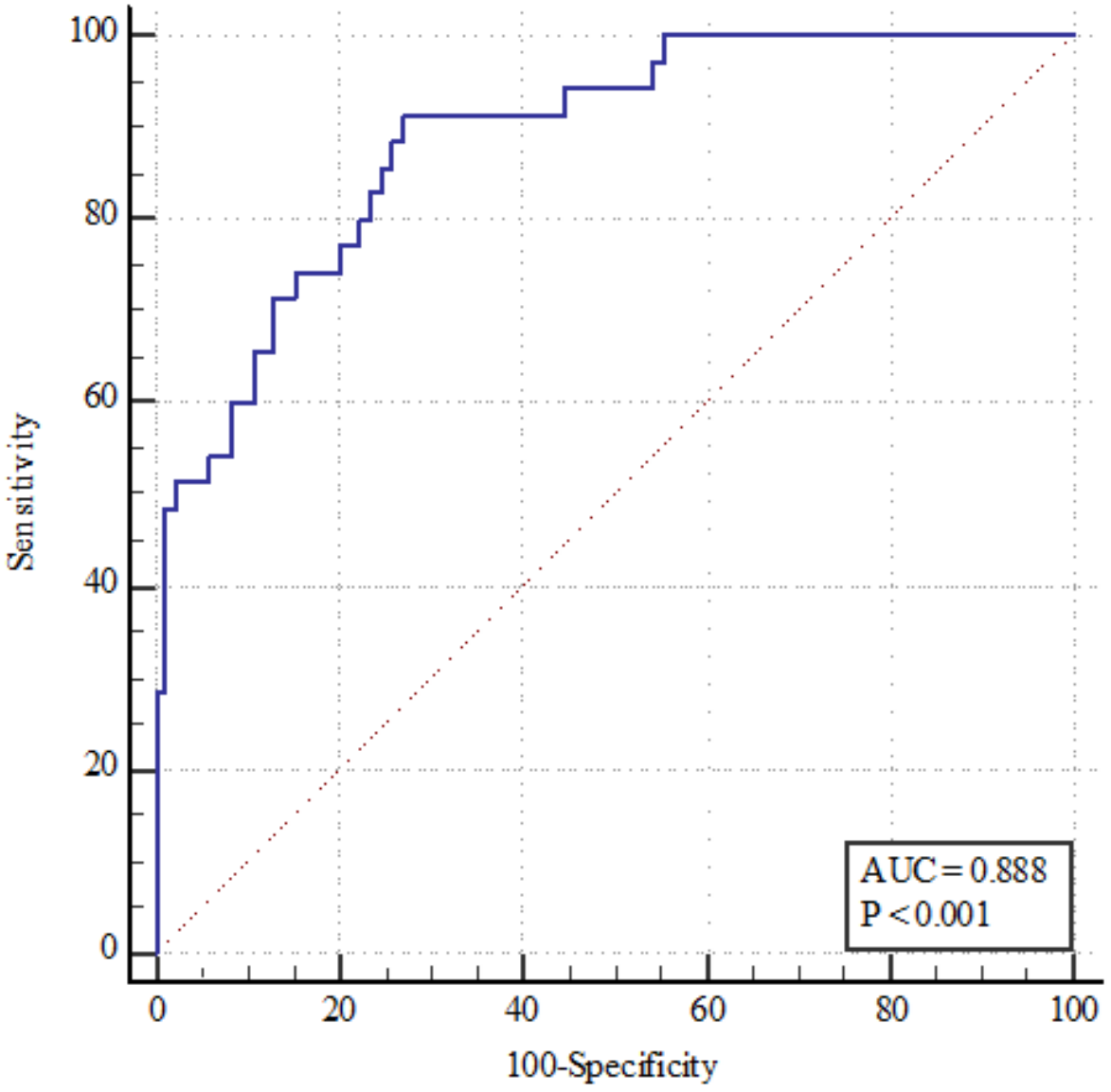

Figure 2: Receiver operating characteristic curve analysis for RAS predicting using demographic and clinical features of patients.

Table 1: Demographic and clinical characteristics of the patients

Parameters*	non-spastic(85)	1 spasm(10)	2 spasm(12)	3 spasm(6)	4 spasm(7)
Age (year)	51.64±9.51	45.1±10.57	59.75±13.85	56.83±14.13	62±7.70
Sex (male/female)	58/27	6/4	7/5	1/5	0/7
Weight (kg)	83.62±8.25	79.9±10.52	83.25±7.44	85.16±10.2	84.57±10.89
Height (cm)	173.8±46.7	171.8±8.10	172.4±6.2	164.66±8.57	164.57±4.39
Body Mass Index (kg/m2)	27.75±2.93	27.03±3.02	28.06±2.9	31.75±8.05	31.22±3.96
Radius bone length (cm)	27.5±1.38	26.9±0.73	27.08±0.66	26.66±0.81	26.42±0.78
Radial artery diameter (mm)	2.97±0.45	2.24±0.52	2.82±0.37	2.53±0.42	2.45±0.5
Procedure duration (minutes)	11.58±2.47	13.3±3.26	14.41±1.83	14±3.79	18±3.31
Tobacco use (positive/negative)	30/55	5/5	6/6	4/2	4/3
High blood pressure (positive/negative)	34/51	2/8	4/8	5/1	4/3
Diabetes mellitus (positive/negative)	30/55	3/7	9/3	5/1	7/0
First puncture attempt (positive/negative)	69/16	8/2	9/3	5/1	2/5
Number of catheters (1/2)	76/9	7/3	8/4	4/2	4/3

*Quantitative and qualitative variables are shown as mean ± standard deviation and number, respectively.

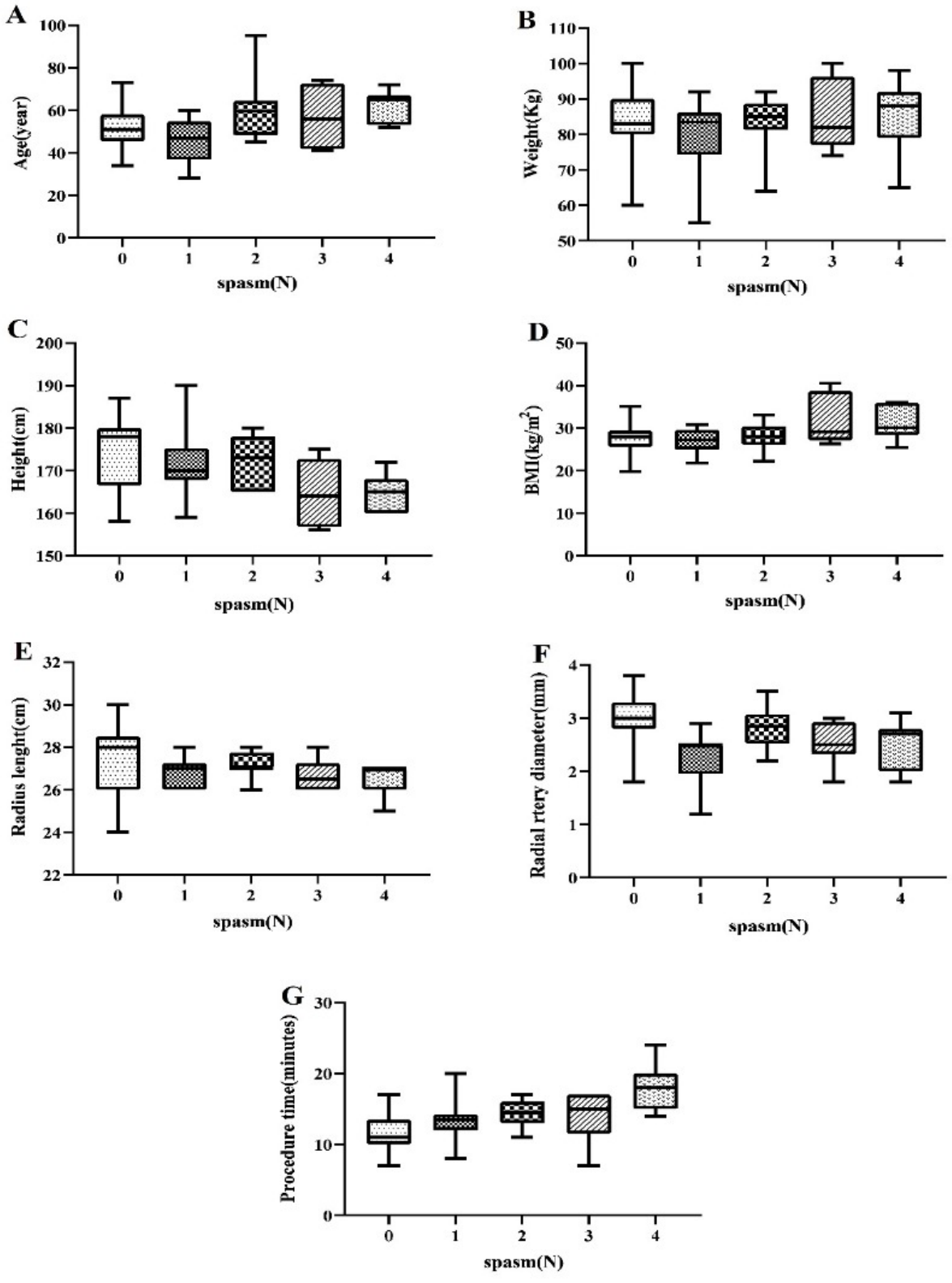

Figure 3: Evaluation of the association of spasm severity with A) Age, B) Weight, C) Height, D) BMI, E) Radius length, F) Radial artery diameter and, G) Procedure time. Results are presented in Mean ± SEM. p-value less than 0.05 is considered significant.

Table 2: Post-hoc test in comparison groups with different spasm severities

parameter	Comparison group	Mean Diff.	95% CI of diff.	P Value
Age	0 spasm vs. 1 spasm	6.535	-2.962 to 16.03	0.3194
	0 spasm vs. 2 spasm	-8.115	-16.88 to 0.6456	0.0834
	0 spasm vs. 3 spasm	-5.198	-17.20 to 6.802	0.7510
	0 spasm vs. 4 spasm	-10.36	-21.54 to 0.8057	0.0825
	1 spasm vs. 2 spasm	-14.65	-26.81 to -2.487	0.0098*
	1 spasm vs. 3 spasm	-11.73	-26.40 to 2.936	0.1809
	1 spasm vs. 4 spasm	-16.90	-30.90 to -2.901	0.0096*
	2 spasm vs. 3 spasm	2.917	-11.29 to 17.12	0.9793
	2 spasm vs. 4 spasm	-2.250	-15.76 to 11.26	0.9906
	3 spasm vs. 4 spasm	-5.167	-20.97 to 10.64	0.8941
Height	0 spasm vs. 1 spasm	13.32	-	>0.9999
	0 spasm vs. 2 spasm	8.859	-	>0.9999
	0 spasm vs. 3 spasm	37.57	-	0.1034
	0 spasm vs. 4 spasm	41.89	-	0.0213*
	1 spasm vs. 2 spasm	-4.458	-	>0.9999
	1 spasm vs. 3 spasm	24.25	-	>0.9999
	1 spasm vs. 4 spasm	28.57	-	0.9458
	2 spasm vs. 3 spasm	28.71	-	0.9781
	2 spasm vs. 4 spasm	33.03	-	0.4523
	3 spasm vs. 4 spasm	4.321	-	>0.9999
BMI	0 spasm vs. 1 spasm	0.7124	-2.253 to 3.678	0.9633
	0 spasm vs. 2 spasm	-0.3163	-3.052 to 2.419	0.9977
	0 spasm vs. 3 spasm	-4.001	-7.748 to -0.2547	0.0301*
	0 spasm vs. 4 spasm	-3.475	-6.963 to 0.01237	0.0513
	1 spasm vs. 2 spasm	-1.029	-4.826 to 2.769	0.9439
	1 spasm vs. 3 spasm	-4.714	-9.294 to -0.1334	0.0404*
	1 spasm vs. 4 spasm	-4.188	-8.559 to 0.1833	0.0672
	2 spasm vs. 3 spasm	-3.685	-8.120 to 0.7498	0.1514
	2 spasm vs. 4 spasm	-3.159	-7.377 to 1.059	0.2378
	3 spasm vs. 4 spasm	0.5260	-4.409 to 5.461	0.9983
Radial artery diameter	0 spasm vs. 1 spasm	45.41	-	0.0009*
	0 spasm vs. 2 spasm	13.49	-	>0.9999
	0 spasm vs. 3 spasm	33.24	-	0.2298
	0 spasm vs. 4 spasm	36.19	-	0.0783
	1 spasm vs. 2 spasm	-31.92	-	0.3125
	1 spasm vs. 3 spasm	-12.17	-	>0.9999
	1 spasm vs. 4 spasm	-9.214	-	>0.9999
	2 spasm vs. 3 spasm	19.75	-	>0.9999
	2 spasm vs. 4 spasm	22.70	-	>0.9999
	3 spasm vs. 4 spasm	2.952	-	>0.9999
Procedure duration	0 spasm vs. 1 spasm	-18.34	-	>0.9999
	0 spasm vs. 2 spasm	-34.90	-	0.0107*
	0 spasm vs. 3 spasm	-30.11	-	0.3931
	0 spasm vs. 4 spasm	-58.58	-	0.0002*
	1 spasm vs. 2 spasm	-16.56	-	>0.9999
	1 spasm vs. 3 spasm	-11.77	-	>0.9999
	1 spasm vs. 4 spasm	-40.24	-	0.1821
	2 spasm vs. 3 spasm	4.792	-	>0.9999
	2 spasm vs. 4 spasm	-23.68	-	>0.9999
	3 spasm vs. 4 spasm	-28.48	-	>0.9999