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Original Article

Diagnostic value of myocardial bridge-mural coronary artery vascular morphology based on CTA technique

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Abstract: Objective: To investigate the diagnostic value of coronary CT angiography (CTA) technique on the vascular morphology of the myocardial bridge-mural coronary artery (MB-MCA). Methods: In this retrospective study, 180 patients with suspected MB-MCA attending Hebei Huaao Hospital from February 2019 to February 2020 were analyzed. The image quality, myocardial bridge distribution, type, length, and degree of stenosis of wall coronary vessels were compared between CTA and Coronary angiography (CAG). The area under the curve (AUC) was used to analyze the diagnostic efficiency of CTA. Results: There was no difference in the excellent CTA image quality rate between the two methods ($P > 0.05$). The mean length of myocardial bridges measured by CTA was greater than that measured by CAG ($P < 0.05$), while the mean degree of stenosis measured by CTA was lower than that measured by CAG ($P < 0.05$). The Kappa value of CTA for determining MB-MCA stenosis versus CAG results was 0.831 ($P < 0.05$); The Kappa value of CTA for determining MB-MCA versus CAG results was 0.895 ($P < 0.05$). The receiver operating characteristic (ROC) curve analysis showed that the AUC was 92.41, sensitivity was 98.73%, and specificity was 92.47% ($P < 0.05$). Conclusions: CTA showed good distribution and length of myocardial bridges, high accuracy for MB-MCA assessment and diagnosis, and good agreement with the gold standard CAG diagnosis.

Keywords: CTA, coronary angiography, myocardial bridge-mural coronary artery, vascular morphology, diagnostic value

Introduction

A myocardial bridge (MB) is an anomalous structure of congenital coronary artery development in coronary vascular disease, covering an internally coursing coronary segment known as a mural coronary artery (MCA) [1]. MCAs are commonly found in single or multiple myocardial bridges. The MCA can cause direct compression of the coronary artery in this location, accelerating abnormal myocardial blood supply during exercise or accelerating the heart rate, inducing a transient decrease in blood supply, and causing symptoms such as chest tightness and shortness of breath [2, 3]. It has been clinically reported that angina pectoris and arrhythmias occur in patients with stenosis > 40%, and that alterations in the ST-T segment and T waves in patients are independent risk factors for the occurrence of sudden cardiac death [4]. Therefore, early diagnosis and timely treatment of MB-MCA patients are of positive significance in controlling the progression of the disease.

Coronary angiography (CAG) is recognized as the “gold standard” in the clinical evaluation of coronary artery disease, providing a clear and accurate diagnosis of the extent of coronary arteries, MB, and collateral circulation formation. However, its invasiveness, complications and high cost limit its clinical application [5]. With the gradual maturation of coronary CT angiography (CTA) technology, the application rate of coronary artery lesions in clinical practice has been improved due to its advantages of high resolution, fast imaging speed, and the ability to obtain clear images in a short period of time [6]. However, there are few studies on the effect of CTA on the diagnosis of MB-MCA vascular morphology, and the research populations are uneven, leading to no clear and unified conclusion. Here, we used clinical data to further validate the value of CTA for diagnosing MB-MCA. In this study, we compared the detection results of CTA with CAG to provide a reference for early clinical identification and intervention of MB-MCA.

Data and methods

Study design and patient selection

In this retrospective analysis, 180 patients with suspected MB-MCA who attended Hebei Huaao Hospital from February 2019 to February 2020 were enrolled, including 97 males and 83 females, with an age ranged from 18 to 76. There were 47 cases that had diabetes, 81 cases with hypertension, 19 cases with cardiomyopathy and 5 cases of heart valve disease. 85 cases had a family history of coronary artery disease. The clinical symptoms included 83 cases with chest tightness, 96 cases with chest pain, and 68 cases with palpitations. This study was approved by the Hebei Huaao Hospital Ethics Committee.

Inclusion criteria: (1) Patients with complete clinical data. (2) Patients with age > 18. (3) Patients with clinical symptoms such as chest tightness, chest pain, and palpitations. (4) Patients with no previous history of allergy to contrast media. (5) Patients who have undergone CAG and CTA examination for the first time in our hospital.

Exclusion criteria: (1) Patients with a history of previous stenting, coronary intervention or arterial bypass grafting. (2) Patients with combined malignancy. (3) Patients with acute coronary syndrome, chronic coronary artery occlusion, or heart rate disorders. (4) Patients with abnormal organ function, such as liver or kidney failure. (5) Patients with mental illness or cognitive impairment who are unable to cooperate in the completion of the study.

Outcome measures

CTA examination: An iodine allergy test was performed before the scan to monitor any allergic reactions for 10 min. A Revolution 256-layer spiral CT scanner (Shenzhen Anke High Technology Co., Ltd.) was used for the examination. Parameters: voltage tube 120 kv, tube current 800 mA, layer thickness 0.625, nonionic contrast machine Haixol (General Electric Pharmaceuticals Shanghai Co., Ltd., Onepac Iodine Haixol Injection, State Pharmacopoeia H20000595) was used for the enhancement scan. Iohexol with a dose of 70~100 mL was injected at a rate of 5 ml per second under a fully automatic high-pressure syringe through the median elbow vein, and the contrast tracking technique was switched on to scan the tracheal ramus to the location of the cardiac septum for 8~10 s. Image data were reconstructed twice and uploaded to the workstation for image analysis.

CAG examination: A PhilipFD-200 digital subtraction angiograph (Philips China) was used. The same contrast agent, iohexol, was injected from the puncture site of the radial artery, and the right and left coronary arteries were imaged at 25 frames/second for diagnosis.

Image quality control: Two personnel at the level of chief physician or higher level in the CT department were invited to evaluate the images, and any different opinions were subjected to consultation with the department head to reach an agreement on the diagnosis. The quality of the images was also evaluated. Excellent: the canal wall was displayed in a clear and smooth way without obvious artefacts or interruption of vessels; good: blurred and slight artefacts were seen; poor: blurred canal wall with significant artefacts observed. Excellent or good rate = (excellent + good)/total number of cases × 100%.

Data collection

Basic clinical data: One doctor collected basic clinical information of patients, including gender, age, body mass index, disease history, and others.

The detection results: CTA and CAG results of patients were collected from imaging records, including image quality, myocardial bridge distribution, length of myocardial bridges, and stenosis degree of myocardial bridge.

Observation indicators

Diagnostic criteria for MB-MCA: The diagnosis of MB-MCA was referred to the Coronary Artery Disease Reporting and Data System - CAD-RADS [7]: (1) CTA diagnostic criteria: Complete or partial myocardial encapsulation of the coronary artery segments, while the proximal and distal segments of that coronary artery travel in

Table 1. Confirmed diagnosis of MB-MCA in 180 patients

Method of Examination	MB-MCA	MB-MCA stenosis	MB-MCA type	
			Deeply buried	Superficially buried
CAG	106 (58.89)	94 (88.68)	58 (54.72)	48 (45.28)
CTA	112 (62.22)	92 (82.14)	62 (55.36)	50 (44.64)
χ^2	0.419	0.357	0.009	
P	0.518	0.165	0.924	

Note: MB-MCA: myocardial bridge-mural coronary artery, CAG: coronary angiography, CTA: coronary CT angiography.

epicardial fatty tissue. (2) CAG diagnostic criteria: There was no clear visualization or even no visualization of the coronary artery in systole in at least 2 projection positions, while the diastolic phase was normally visualized, known as the “milking effect”. A completely encircled vessel was considered deep. Superficial: myocardial encirclement was present in ≥ 50% of the circumference of the vessel.

Distribution of myocardial bridges: The analysis was performed with reference to the American Heart Association (AHA) [8] segmental method, and coronary assessment software was applied to diagnose MB-MCA, observing the distribution of the left anterior descending branch, left circumflex branch, right coronary artery, and intermediate branch coronary artery courses.

Mean length of myocardial bridges and degree of stenosis: Average myocardial bridge length: The length of the coronary artery from the beginning of the myocardial segment to the end of the myocardial segment was measured in the diastolic image as the myocardial bridge length, and the myocardial bridge length was measured three times and averaged.

Degree of stenosis: degree of MCA stenosis (%) = [(normal vessel diameter proximal to the stenotic segment - vessel diameter at the stenosis)/normal vessel diameter proximal to the stenotic segment] × 100%; severe: MCA stenosis > 75%; moderate: MCA stenosis between 50% and 75%; mild: MCA stenosis < 50%.

Statistical analysis

SPSS 26.0 was applied for analysis, and the measured data conforming to a normal distribution were expressed as (mean ± SEM), and the t-test was used for comparison between groups. Counted data were expressed using the number of cases/percentage (n/%), and the χ^2 test was used for comparison of data between groups. The consistency of the examination method with the gold standard was tested by the Kappa test, and ROC curve analysis was used for CTA diagnostic efficacy. α=0.05 was considered significant.

Results

Confirmation of MB-MCA in 180 patients

The final diagnosis of MB-MCA by CTA in 180 patients was 62.22% (112/180) and 82.14% (92/112) for MB-MCA stenosis: 55.36% (62/112) for the deeply buried type and 44.64% (50/112) for the superficially buried type. The final diagnosis of MB-MCA by CAG was 58.89% for (106/180), 86.68% (94/106) for MB-MCA stenosis: 54.72% (58/106) for deeply buried, 45.28% (48/106) for MB-MCA shallowly buried. There were no differences between the two groups in these performances (P > 0.05), see **Table 1**.

Image quality analysis of the two examination methods

The rate of CTA excellent imaging was 98.90%, which was slightly higher than 97.22% of CAG, but the difference was not significant (P > 0.05), see **Table 2**.

Comparison of myocardial bridge distribution between CTA and CAG

Myocardial bridge distribution shown in CTA was detected at a higher rate than that shown in CAG in patients with MB-MCA, with a significant difference (P < 0.05), see **Table 3**.

Comparison of CTA and CAG data for each segment of MB-MCA diagnosis

The mean length of myocardial bridges in patients measured by CTA was longer than that

Table 2. Image quality analysis of the two examination methods

Inspection method	Excellent	Good	Poor	Excellent rate
CAG	101 (95.28)	1 (0.94)	4 (3.78)	102 (97.22)
CTA	106 (94.64)	2 (1.79)	4 (3.57)	108 (98.89)
χ^2	8.095	10.638		0.006
P	0.013	0.007		0.937

Note: CAG: coronary angiography, CTA: coronary CT angiography.

Table 3. Comparison of myocardial bridge distribution between CTA and CAG

Examination method	Left anterior descending branch	Left circumflex branch	Right coronary artery	Intermediate branch	Detection rate
CAG	36 (32.14)	20 (17.86)	16 (14.29)	9 (8.03)	81 (72.32)
CTA	39 (36.79)	25 (23.58)	17 (16.03)	14 (13.21)	95 (89.61)
χ^2		-			10.480
P		-			0.001

Note: CAG: coronary angiography, CTA: coronary CT angiography.

Table 4. Comparison of CTA and CAG data for each segment of the MB-MCA diagnosis

Inspection method	Average length (mm)	Average degree of stenosis (%)
CAG	9.68±2.93	38.67±9.59
CTA	14.99±5.06	25.69±7.91
t	9.178	11.943
P	< 0.001	< 0.001

Note: MB-MCA: myocardial bridge-mural coronary artery, CAG: coronary angiography, CTA: coronary CT angiography.

Table 5. Value of CTA and CAG for diagnosing MB-MCA stenosis

CTA	CAG		Total	Kappa Value
	Narrow	Normal		
Narrow	92	2	94	0.831
Normal	3	15	18	
Total	95	17	112	

Note: MB-MCA: myocardial bridge-mural coronary artery, CAG: coronary angiography, CTA: coronary CT angiography.

Table 6. Value of CTA and CAG for diagnosing MB-MCA

CTA	CAG		Total	Kappa Value
	Positive	Negative		
Positive	106	6	112	0.895
Negative	3	65	68	
Total	109	71	180	

Note: MB-MCA: myocardial bridge-mural coronary artery, CAG: coronary angiography, CTA: coronary CT angiography.

by CAG (P < 0.05), while the mean degree of stenosis of the MCA in patients measured by CTA was lower than that of CAG, with a significant difference (P < 0.05), as shown in **Table 4**.

Value of CTA and CAG for diagnosing MB-MCA stenosis

The Kappa value of CTA to determine MB-MCA stenosis versus CAG was 0.831, P < 0.05, with better agreement and a sensitivity of 96.84%, specificity of 88.23%, negative predictive value of 83.33%, and positive predictive value of 97.87% for diagnosing the degree of MB-MCA stenosis, as shown in **Table 5**.

Value of CTA and CAG for diagnosing MB-MCA

The Kappa value of CTA to determine MB-MCA versus CAG results was 0.895, P < 0.05, with better agreement. The sensitivity of each diagnosis of MB-MCA was 97.25%, specificity 91.54%, negative predictive value 95.59%, and positive predictive value 94.64%, as shown in **Table 6**.

Diagnostic efficacy of CTA for assessing MB-MCA

The AUC curve for the diagnosis of MB-MCA by CTA was 92.41, with a sensitivity of 98.73%, specificity of 92.47%, and standard error of 0.021, P < 0.05, 95 CI% 0.883 to 0.967, as shown in **Figure 1** by ROC curve analysis. The

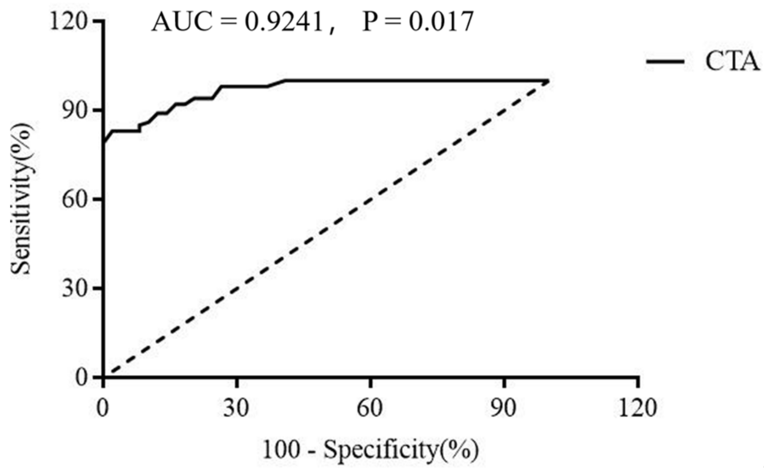

Figure 1. CTA assessment of the diagnostic efficacy of MB-MCA. Note: MB-MCA: myocardial bridge-mural coronary artery, CTA: coronary CT angiography.

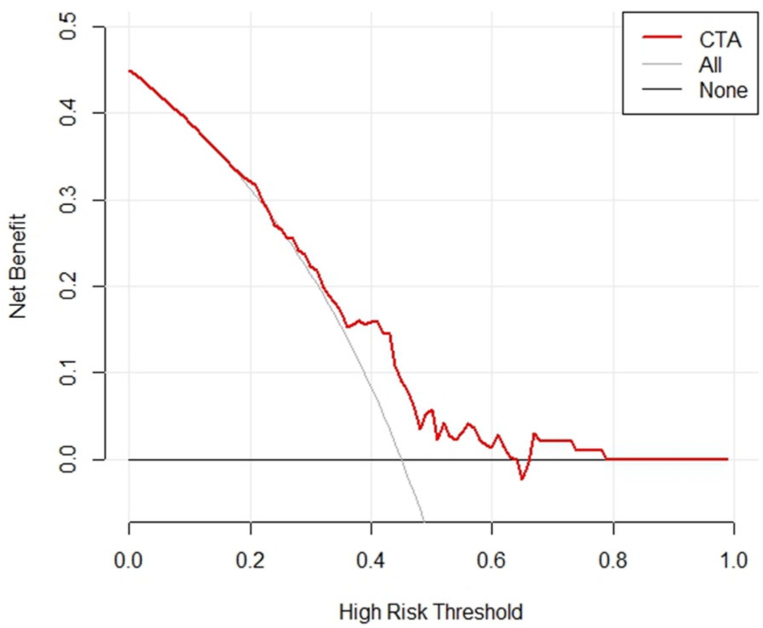

Figure 2. Decision curve analysis (DCA) of the diagnostic efficacy of myocardial bridge-mural coronary artery (MB-MCA). Note: CTA: coronary CT angiography.

decision curve analysis (DCA) showed that when the high-risk threshold was 0.0~0.682 and 0.724~0.800, the net rate of return was greater than 0, which has clinical significance. This suggests that the smaller the high-risk threshold, the greater the net rate of return. Within the threshold range of 0.00~0.450, the CTA prediction model predicted a higher net return rate ($P < 0.05$) (**Figure 2**).

Discussion

Myocardial bridge (MB) was initially considered a benign anatomic lesion of the coronary arteries, but in recent years, it has been found to induce many cardiovascular adverse events, such as myocardial ischemia and arrhythmia [9, 10]. Seitun et al. [11] found that MB type, thickness, and degree of MCA stenosis were associated with coronary atherosclerosis formation in the anterior segment of the bridge. Karna et al. [12] found that MB was associated with coronary artery spasm, ECG ischemic changes, and chest pain, while severe MCA stenosis was a high risk factor for increased coronary artery spasm. In addition, clinical reports have shown that MB shares clinical symptoms with coronary artery disease, but has different treatment options [13]. CAG is the accepted gold standard for the diagnosis of this disease, but requires the placement of a catheter into the relevant aorta and the use of iodine contrast to complete the imaging, which is invasive and has a low level of acceptability due to high complications, affecting its clinical application [14]. The CTA technique is a non-invasive and convenient way to obtain a whole-body vascular image after image data post-processing [15]. The clinical application of this technique in the diagnosis of cardiovascular and cerebrovascular diseases has revealed that CTA technology has a high disease diagnosis rate with no risk of complications and a high safety level [16].

In this study, CTA and CAG were used to diagnose MB-MCA, with CAG as the gold standard.

An autopsy result reported a high diagnostic rate of CAG and a high detection rate for MB-MCA of 85.37%, but the detection rate was low when applied in the clinic [17]. The results of the current study are consistent with previous studies reporting a low detection rate of MB by CAG, suggesting that there is some underdiagnosis by CAG. The reasons for this are: CAG can clearly diagnose the lumen of the vessel but has a limited diagnosis of the cross-section of the vessel, and the milking effect is more difficult to determine when assessing superficial MB. Some authors have pointed out that the leakage rate is higher in CAG examinations with MCA stenosis < 25% [18]. The rate, stenosis, and type of confirmed MB-MCA diagnosis by CTA in the present results were higher than the CAG diagnosis, suggesting that CTA is more advantageous in diagnosing MB-MCA disease, and that the CTA technique can clearly observe the vessel morphology and course, and display the submyocardial encapsulated MCA in all directions.

In this study, the excellent quality rate of CTA was found to be 98.90%, slightly higher than that of coronary angiography 97.22%, but the difference was not statistically significant. The excellent image quality rates of CTA and CAG were above 95%, suggesting that the image quality of these two modalities is satisfactory. The remaining poorer image quality may be affected by the patient's heart rate, respiratory motion, contrast dose or peak time determination on the images, but all can provide an accurate and reliable image basis for clinical diagnosis. In the analysis of myocardial bridge distribution, the detection rate of myocardial bridge distribution in patients with MB-MCA was significantly higher with CTA than with CAG, suggesting that CTA is better for determining myocardial bridge distribution in MB-MCA. This is consistent with the results of a large number of previous studies [19, 20]. The reason for this is that the lower CAG detection rate may be closely related to the body position at the time of examination, the degree of myocardial bridge thickness, and the size of the wall coronary artery vessels. Also, MB-MCA is not conducive to "milking" during diastole if plaque is evident in the proximal segment of the artery, which affects coronary blood flow performance.

In this study, the mean length of myocardial bridges measured by CTA was longer than that of CAG, while the mean stenosis degree of MCA measured by CTA was lower than that of CAG, with a significant difference, suggesting a diagnostic advantage of CTA for myocardial bridge length. It was found that MB does not have sufficient thickness of myocardial fibers in coronary artery walls, while CAG limits the effect of extrusion on coronary artery walls due to less myocardial fibrous connective tissue and thinner thickness during diastolic assessment, further affecting the diagnostic result of CAG [21]. However, CTA has an image post-processing reconstruction function that allows accurate measurement of myocardial bridge length by processing image data by 3D reconstruction. However, in terms of stenosis thickness, the CTA technique is affected by the timing of the heartbeat due to its own inadequate scanning, and some patients' images are in diastole, which is the phase with the lowest floating motion of the cardiac cycle, and the MB-MCA in this phase is not under severe compression and affects the judgment of the degree of stenosis [22]. However, CAG is more accurate in the diagnosis of stenosis because it is a simultaneous dynamic observation of the degree of stenosis and can assess different phases of the cardiac cycle [23].

In the current study, the Kappa values of CTA to determine MB-MCA stenosis that correspond with CAG results were 0.831 and 0.858 respectively, suggesting better agreement. The AUC curve for the diagnosis of MB-MCA by CTA was 92.41, suggesting that CTA examination is effective in diagnosing the rate and evaluating the degree of stenosis in MB-MCA. Similar findings were also found in a previous study, which may be because the CAG lumen is poorly visualized in superficial MB when the myocardium is in contraction, making it more difficult to assess the "milking effect" and thus missing it; it may also be due to the difficulty in visualizing vessel deformation due to changes in wall stiffness after the coronary arteries exhibit atherosclerotic plaque [24].

In the present study, CTA technique was found to be more sensitive and specific for the diagnosis of MB-MCA and can be used as a non-invasive tool for clinical diagnosis of this disease. Its advantage is that the CTA 3D reconstruction technique can observe myocardial morphology on one hand and show the anatomic relationship between myocardial bridges and adjacent tissues in an all-round way. On the other hand, it can accurately measure MB length, thickness, and stenosis and reduce manual measurement errors. However, the CTA technique can only assess the coronary arteries at rest and cannot be observed dynamically; at the same time, the CTA technique is also constrained by cardiac lesions and has high requirements for heart rate, among other shortcomings. The shortcomings of the CTA technique are the advantages of the CAG, which does not need to be affected by the patient's heart and heart rate during the examination and can display the MB dynamically through multiple angles. Therefore, CTA and CAG each have advantages in diagnosing MB-MCA and can be used based on each individual patient.

Conclusions

CTA shows the distribution and length of myocardial bridges well, has high accuracy in the assessment and diagnosis of MB-MCA, and is in good agreement with the gold standard CAG diagnosis. However, there are some shortcomings in this study: first, this is a single-center study and the sample size is limited, which affects the reliability of the results; second, this study has not yet been associated with the prognosis of the disease, and further improvement of these shortcomings is still needed.

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Disclosure of conflict of interest

None.

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References

[1] Zhao DH, Fan Q, Ning JX, Wang X and Tian JY. Myocardial bridge-related coronary heart disease: independent influencing factors and their predicting value. World J Clin Cases 2019; 7: 1986-1995.

[2] Ding H, Zhang Y, Liu Y, Liu Z, Shi C, Nie Z, Chen Z and Zeng Y. Simulated coronary arterial hemodynamics of myocardial bridging. Rev Cardiovasc Med 2019; 20: 273-280.

[3] Tiryakioğlu M and Aliyu MN. Myocardial bridge. Folia Morphol (Warsz) 2020; 79: 411-414.

[4] Murtaza G, Mukherjee D, Gharacholou SM, Nanjundappa A, Lavie CJ, Khan AA, Shanmugasundaram M and Paul TK. An updated review on myocardial bridging. Cardiovasc Revasc Med 2020; 21: 1169-1179.

[5] Teragawa H, Oshita C and Ueda T. The significance of recognizing myocardial bridge in the coronary spasm diagnosis in myocardial infarction with nonobstructive coronary arteries. Intern Med 2020; 59: 89-92.

[6] Mohammadzadeh A, Farzaneh M, Zahedmehr A, Kiani R, Shakiba M, Borhani A, Rouzitalab M, Ahmadi S and Mohammadzadeh M. Coronary CT angiography and dual-energy computed tomography in ischemic heart disease suspected patients. Arch Iran Med 2019; 22: 376-383.

[7] Cury RC, Abbara S, Achenbach S, Agatston A, Berman DS, Budoff MJ, Dill KE, Jacobs JE, Maroules CD, Rubin GD, Rybicki FJ, Schoepf UJ, Shaw LJ, Stillman AE, White CS, Woodard PK and Leipsic JA. CAD-RADS(TM) coronary artery disease - reporting and data system. An expert consensus document of the Society of Cardiovascular Computed Tomography (SCCT), the American College of Radiology (ACR) and the North American Society for Cardiovascular Imaging (NASCI). Endorsed by the American College of Cardiology. J Cardiovasc Comput Tomogr 2016; 10: 269-281.

[8] Otto CM, Nishimura RA, Bonow RO, Carabello BA, Erwin JP 3rd, Gentile F, Jneid H, Krieger EV, Mack M, McLeod C, O'Gara PT, Rigolin VH, Sundt TM 3rd, Thompson A and Toly C. 2020 ACC/AHA guideline for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Joint Committee on clinical practice guidelines. J Am Coll Cardiol 2021; 77: e25-e197.

[9] Roberts W, Charles SM, Ang C, Holda MK, Walocha J, Lachman N, Tubbs RS and Loukas M. Myocardial bridges: a meta-analysis. Clin Anat 2021; 34: 685-709.

[10] Negi SI, Nandar PP and Chaffee RB. Gender disparities in ST elevation myocardial infarction: a time to bridge the gap. Cardiovasc Revasc Med 2021; 31: 48-49.

[11] Seitun S and Alkadhi H. Plaques, stenosis and subtended myocardial mass: CT crosses the bridge from morphology to function. J Cardiovasc Comput Tomogr 2021; 15: 46-47.

[12] Karna SK, Chourasiya M, Parikh RP, Chaudhari T and Patel U. Prevalence of myocardial bridge in angiographic population-a study from rural

part of western India. J Family Med Prim Care 2020; 9: 1963-1966.

[13] Cai DX, Shi JX, Zhao XB and Qi Z. Correlation between coronary artery tortuosity and stenosis in patients with myocardial bridge. Zhongguo Yi Xue Ke Xue Yuan Xue Bao 2020; 42: 766-770.

[14] Papp S, Bárczi G, Karády J, Kolossváry M, Drobni ZD, Simon J, Boussoussou M, Vattay B, Szilveszter B, Jermendy G, Merkely B and Maurovich-Horvat P. Coronary plaque burden of the left anterior descending artery in patients with or without myocardial bridge: a case-control study based on coronary CT-angiography. Int J Cardiol 2021; 327: 231-235.

[15] Horev A, Honig A, Cohen JE, Goldbart A, Dizitzer Y, Star M, Gomori JM, Zlotnik Y, Ifergane G, Borodetsky V, Shelef I and Leker RR. Overestimation of carotid stenosis on CTA - real world experience. J Clin Neurosci 2021; 85: 36-40.

[16] Sharif D. Editorial commentary: coronary computed tomography angiography (CTA): implications and challenges. Trends Cardiovasc Med 2022; 32: 429-430.

[17] Aghajani H, Hosseini K, Alizadeh S and Aghajani R. Challenging case of muscle bridge; a 15-year follow-up of a patient. Caspian J Intern Med 2020; 11: 120-123.

[18] Yu Y, Yu L, Dai X and Zhang J. CT fractional flow reserve for the diagnosis of myocardial bridging-related ischemia: a study using dynamic CT myocardial perfusion imaging as a reference standard. Korean J Radiol 2021; 22: 1964-1973.

[19] Darabont RO, Vișoiu IS, Magda ȘL, Stoicescu C, Vintilă VD, Udroiu C and Vinereanu D. Implications of myocardial bridge on coronary atherosclerosis and survival. Diagnostics (Basel) 2022; 12: 948.

[20] Pargaonkar VS, Rogers IS, Su J, Forsdahl SH, Kameda R, Schreiber D, Chan FP, Becker HC, Fleischmann D, Tremmel JA and Schnittger I. Accuracy of a novel stress echocardiography pattern for myocardial bridging in patients with angina and no obstructive coronary artery disease - a retrospective and prospective cohort study. Int J Cardiol 2020; 311: 107-113.

[21] Cheng SH, Ni J, Liu J, Huang F and Wang PJ. The role of artificial intelligent-based FFR(CT) in assessing the hemodynamic relevance of deep myocardial bridge of the left anterior descending coronary artery. Zhonghua Yi Xue Za Zhi 2021; 101: 464-469.

[22] Abadie B and Jaber W. Dobutamine stress PET/CT for assessment of hemodynamic significance of coronary myocardial bridges. J Nucl Cardiol 2022; 29: 1447-1451.

[23] He X, Ahmed Z, Liu X, Xu C and Zeng H. Recurrent attack of acute myocardial infarction complicated with ventricular fibrillation due to coronary vasospasm within a myocardial bridge: a case report. BMC Cardiovasc Disord 2020; 20: 385.

[24] Erdem K and Ozbay Y. Prevalence and characteristics of coronary artery anomalies using invasive coronary angiography in 6237 consecutive patients in a single center in Turkey. Arch Iran Med 2018; 21: 240-245.