Usefulness of Prominently Projected Aortic Arch on Chest Radiograph to Predict Severe Tortuosity of the Right Subclavian or Brachiocephalic Artery in Patients Aged >44 Years Undergoing Coronary Angiography With a Right Radial Artery Approach

メタデータ	言語: English
	出版者:
	公開日: 2014-03-20
	キーワード (Ja):
	キーワード (En):
	作成者: 西﨑, 祐史
	メールアドレス:
	所属:
URL	https://jair.repo.nii.ac.jp/records/2001601

Original Articles

Usefulness of a Prominently Projected Aortic Arch on Chest Radiograph to Predict Severe Tortuosity of the Right Subclavian or Brachiocephalic Artery in Patients >44 Years of Age Undergoing Coronary Angiography with a Right Radial Artery Approach

Yuji Nishizaki, MD[1], Shinichiro Yamagami, MD[1], Keiichi Haga, MD[1], Masahiro Sesoko, MD[1], Haruyo Yamashita, MD[1], Katsumi Miyauchi, MD[2] , Hiroyuki Daida, MD[2]

[1]Juntendo University School of Medicine, Juntendo Tokyo Koto Geriatric Medical Center, Department of Cardiology

[2]Juntendo University School of Medicine, Department of Cardiology

Running Head: Predictors of Severe Arterial Tortuosity

Corresponding author: Yuji Nishizaki, MD

Department of Cardiology, Juntendo University School of Medicine, Juntendo Tokyo Koto Geriatric Medical Center, Shinsuna 3-3-20, Koto-Ku, Tokyo 136-0075, Japan

TEL: +81-3-5632-3111; FAX: +81-3-5632-3728; E-mail: ynishiza@juntendo.ac.jp

Abstract: Although it is well known that certain characteristics, such as older age, female sex, hypertension, and high body mass index (BMI), are closely associated with severe arterial tortuosity among patients undergoing transradial coronary angiography (CAG), few data are available regarding useful predictors of severe arterial tortuosity among geriatric patients. The purpose of this study was to evaluate the characteristics of geriatric patients with severe tortuosity of the right subclavian artery (RSA) or brachiocephalic artery (BCA). The coronary angiographic reports of patients with severe tortuosity of the RSA or BCA and age- and sex-matched control patients were retrospectively evaluated. A total of 847 consecutive patients underwent right transradial CAG; 48 patients (5.7%) had severe tortuosity (29 females, age 73.4±8.6 years). The factors associated with severe arterial tortuosity were higher BMI [odds ratio (OR) 1.17, $p=0.02$], presence of a prominently projected aortic arch on chest X-ray (OR 5.62, $p<0.01$), and lower serum creatinine value (OR 0.05, $p<0.01$). In conclusion, presence of a prominently projected aortic arch on chest X-ray is a useful predictor of severe arterial tortuosity.

Key words: prominently projected aortic arch; severe tortuosity; subclavian artery; brachiocephalic artery

Introduction: The transradial approachfor coronary angiography (CAG) has gained popularity because it results in no major ischemic complications in cases of occlusion in patients with normal Allen test, better patient comfort, and no need for bed rest after the procedure.[1-3] The right radial artery is commonly used because most catheterization laboratories are set up for a right sided patient approach. With the super aging of society as in Japan, the number of geriatric patients undergoing CAG is expected to increase. It is well known that older age, female sex, hypertension, and high body mass index (BMI) are closely associated with severe tortuosity of the right subclavian artery (RSA).[4] However, for geriatric patients in particular, few data are available regarding useful predictors for severe arterial tortuosity. We hypothesize that presence of a prominently projected aortic arch on chest X-ray is a useful predictor of severe arterial tortuosity.

Methods: Consecutive patients who underwent right transradial CAG with severe tortuosity of the RSA or BCA were retrospectively evaluated. Age- and sex-matched control patients who underwent right transradial CAG without tortuosity of the RSA or BCA were also evaluated. All cases and control patients were identified by a review of all coronary angiographic reports from July 2003 to

August 2011. Patients were excluded if they were on hemodialysis, needed repeat examinations with the right radial artery approach, and needed alternative arterial access due to failure of right radial artery puncture or the presence of significant stenosis of the right radial artery. All patients provided written informed consent to undergo CAG. The study was approved by Institutional ethics committee of Juntendo Tokyo Koto Geriatic Medical Center.

Because there is no clear definition of severe tortuosity of the RSA and BCA, severe tortuosity of the RSA or BCA was arbitrarily defined as major difficulty in passing the tortuous RSA or BCA using a flexible hydrophilic guidewire (Radifocus, Terumo, Tokyo, Japan) to support the catheter and complete angiography (Figure 1) or alternative arterial access was needed due to the tortuous RSA or BCA. All cases of severe tortuosity of the RSA or BSA were recorded in coronary angiographic reports.

Baseline characteristics and clinical data of the present study patients were collected from medical records that were reviewed by experienced cardiologists. Cardiovascular risk factors, including smoking habit, systemic hypertension, hypercholesterolemia, diabetes mellitus, and family history of cardiovascular disease, were assessed. Smoking habit was divided into three categories: current, former, and never smoker. Former smoker was defined as previous smoking (>2 pack-years). Systemic hypertension was defined as blood pressure ≥140/90 mmHg or medically treated. Hypercholesterolemia was defined as total cholesterol ≥220 mg/dL, low-density lipoprotein (LDL) cholesterol ≥140 mg/dL, high-density lipoprotein (HDL) cholesterol ≤40 mg/dL, fasting triglycerides ≥150 mg/dL, or medically treated. Diabetes mellitus was defined as fasting plasma glucose ≥126 mg/dL, postprandial blood glucose ≥200 mg/dL, or medically treated. Weight, height, body mass index (BMI), and body surface area (BSA) were also assessed. BMI was defined as body weight (kg) divided by the square of the height (m). BSA was calculated from the body weight and height using the Du Bois formula: BSA (m^2) = $0.007184 \times \text{height}^{0.725} \times \text{body weight}^{0.425}$. Patients were also evaluated for concurrent atrial fibrillation, dementia, history of malignancy, stroke, and use of medications (statins, anti-platelet agents, angiotensin converting enzyme inhibitors, angiotensin II receptor blockers, calcium channel blockers, beta blockers, warfarin, and diuretics). The clinical indications for CAG were also assessed using four categories: stable angina pectoris, acute coronary syndrome, atypical chest pain, and others.

Echocardiographic examination was performed using a commercially-available echocardiographic machine (Sonos 5500, Philips, Bothell, WA, USA). Almost all patients underwent a comprehensive examination that included two-dimensional and Doppler echocardiography by an experienced sonographer or cardiologist before CAG. Interventricular septal wall thickness (IVST), posterior wall thickness (PWT), LV end-diastolic dimension (LVDd), LV end-systolic dimension (LVDs), left ventricular mass index (LVMI), relative wall thickness, LV ejection fraction, presence of asynergy, early diastolic filling wave to atrial filling wave ratio (E wave to A wave ratio), left atrial dimension, aortic valve annulus dimension, and aortic valve peak velocity were evaluated. The LV end-diastolic volume (EDV) and end-systolic volume (ESV) were measured by the disk method using two-dimensional images obtained from both the apical 4- and 2-chamber views. LV ejection fraction was calculated by the following equation: $100 \times (EDV - ESV) / EDV$. LVMI was calculated using the formula recommended by the American Society of Echocardiography: LVMI (g / m^2) = $(1.04 [(IVST + \text{left ventricular internal diameter} + PWT)^3] – 14 g) / BSA$.[5] Relative wall thickness was calculated using the following formula: $[(PWT + IVST) / LVDd]$.[5] Almost all patients underwent ankle-brachial index and pulse wave velocitytesting. All patients underwent an electrocardiogram (ECG) before CAG. Lower ankle-brachial index and higher pulse wave velocity values, as well as ECG voltage, were evaluated. ECG voltage was calculated using S1 plus R5. The following laboratory data were assessed: hemoglobin, red blood cell distribution width, creatinine, hemoglobin A1c, total cholesterol, LDL cholesterol, HDL cholesterol, LDL to HDL ratio, triglycerides, and brain natriuretic peptide.

CAG by the right radial artery approach was performed via standard Judkins techniques with a flexible hydrophilic guidewire (Radifocus, Terumo, Tokyo, Japan) or multipurpose catheter technique in all patients. Results of CAG, including the presence or absence of severe tortuosity of the RSA or BSA, were reported by the most experienced cardiologist in the institution. The severity of coronary stenosis was visually determined and expressed as percent luminal diameter. Stenosis was considered significant if it was >75% according to the American Heart Association (AHA) guideline. The presence or absence of significant lesions, double-vessel disease, triple-vessel disease, and left main coronary trunk lesions was evaluated.

All patients underwent chest X-ray examination (posteroanterior view) before CAG. The cardiothoracic ratio, presence or absence of a prominently projected aortic arch, and presence or absence of aortic arch calcification were evaluated.

Because there is no clear definition of a prominently projected aortic arch on chest X-ray, presence of a prominently projected aortic arch was arbitrarily defined as distance from the neck of the aortic arch to the left edge of the aortic arch ≥10 mm. This definition of a prominently projected aortic arch is shown in Figure 2.

Results are expressed as means ± standard deviation or as numbers and ratios (%). Continuous variables were compared using the unpaired *t*-test. Categorical variables were compared using the chi-square test. Significant variables related to severe tortuosity of the RSA or BCA were determined using a multivariate logistic regression model. Variables with a p value <0.10 in the univariate analysis were also entered in the multivariate logistic regression model. All statistical analyses were conducted using SAS Enterprise Guide 4 software (SAS Institute Inc. Cary, NC, USA). Statistical significance was defined as a p value <0.05.

Results: The total number of consecutive patients who underwent CAG with the RRA approach was 860, and the number of patients who fulfilled the inclusion criteria was 847. All patients' characteristics are shown in Table 1. When the prominently projected aortic arch on chest X-ray was categorized, the odds ratio (OR) for the presence of severe tortuosity of the RSA or BCA was 5.62 for patients whose distance from the neck of the aortic arch to the left edge of the aortic arch was ≥10 mm (n=26) compared with a distance <10 mm (n=21) and 5.39 in patients whose distance was ≥15 mm (n=9) compared with a distance <15 mm (n=38). Two patients (1.4%) were difficult to evaluate in the present study. One patient had a prominent pulmonary artery (Figure 3). The other patient was post thoracoplasty (Figure 4). Table 2 shows the results of multivariate logistic regression analysis. Body weight (p=0.08) was not entered in the multivariate logistic regression analysis, because body weight shows a close correlation with BMI.

Discussion: We revealed the presence of a prominently projected aortic arch on chest X-ray, higher BMI and lower serum creatinine value were useful predictors of severe tortuosity of the RSA or BCA in geriatric patients.

In 2003, Kwang et al. reported that clinical predictors of severe tortuosity of the RSA was were systemic hypertension, female sex, older age, nonsmoker, short stature, and high BMI.[4] This study provided systematic data regarding severe tortuosity of the RSA in a large patient population, but it had limitations. The results of this study are not applicable to geriatric patients. The mean age of the patients in this study was 10 years younger than our study. Since most geriatric patients take antihypertensive agents for systemic hypertension, systemic hypertension is not a suitable predictor of severe tortuosity in geriatric patients. An advantage of the present study was the multifactorial analysis that included imaging modality, physiological tests, and laboratory data that could affect severe tortuosity in geriatric patients. The results of these examinations were quantitative and reliable data. In particular, all patients undergo a chest X-ray as a routine examination before CAG, and the presence of a prominently projected aortic arch on chest X- ray is obvious at a glance (Figure 2). We consider that the presence of a prominently projected aortic arch on chest X-ray indicates the presence of long-standing systemic hypertension. Although several hypotheses for the mechanism of the tortuosity based on experimental studies have been reported,[6-8] the mechanism has not been sufficiently clarified. A congenital abnormality is one possible reason.[9-11] Another reason is contractility of vascular smooth muscle. [6-7] We presume that higher BMI is related to tortuosity through the contractility of vascular smooth muscle. A lower serum creatinine value represents low muscle mass.[12] A higher BMI is associated with a higher body fat percentage. Thus, we hypothesize that a lower serum creatinine value indicates a higher BMI. Indeed, Verhave et al. reported that the estimation of renal function by the Cockcroft-Gault formula was overestimated by obesity .[13]

The limitations of this study include its retrospective design, small size, and single-center sample. Furthermore, in a few cases, it was difficult to evaluate the aortic arch on chest X-ray, for example, patients with a prominent pulmonary artery. Indeed, two patients (1.4%) were difficult to evaluate in the present study. One patient had a prominent pulmonary artery (Figure 3). The other patient was post thoracoplasty (Figure 4). A large prospective study is required in the future to validate the present results.

You should evaluate a prominently projected aortic arch on chest X-ray prior to CAG to stratify patients to right radial versus femoral artery approach.

Acknowledgements: The authors would like to thank Dr. Hiroko Tsunoda and Dr. Takuya Ueda, St. Luke's International Hospital Department of Radiology, for their advice on chest X-ray interpretation.

[1] Mann T, Cubeddu G, Bowen J, Schneider JE, Arrowood M, Newman WN, Zellinger MJ, Rose GC. Stenting in acute coronary syndromes: a comparison of radial versus femoral access sites. *J Am Coll Cardiol* 1998;32:572-576.

[2] Saito S, Miyake S, Hosokawa G, Tanaka S, Kawamitsu K, Kaneda H, Ikei H, ShionoT. Transradial coronary intervention in Japanese patients. *Catheter Cardiovasc Interv* 1999;46:37-41.

[3] Franchi E, Marino P, Biondi-Zoccai GG, De Luca G, Vassanelli C, Agostoni P. Transradial versus transfemoral approach for percutaneous coronary procedures. *Curr Cardiol Rep* 2009;11:391-397.

[4] Cha KS, Kim MH, Kim HJ. Prevalence and clinical predictors of severe tortuosity of right subclavian artery in patients undergoing transradial coronary angiography. *Am J Cardiol* 2003;92:1220-1222.

[5] Lang RM, Bierig M, Devereux RB, Flachskampf FA, Foster E, Pellikka PA, Picard MH, Roman MJ, Seward J, Shanewise JS, Solomon SD, Spencer KT, Sutton MS, Stewart WJ. Recommendations for chamber quantification: a report from the American Society of Echocardiography's Guidelines and Standards Committee and the Chamber Quantification Writing Group, developed in conjunction with the European Association of Echocardiography, a branch of the European Society of

Cardiology. *J Am Soc Echocardiogr* 2005;18:1440-1463.

[6] Azuma T, Ohhashi T, Sakaguchi M. Vibration-induced hyperresponsiveness of arterial smooth muscle to noradrenaline with special reference to Raynaud's phenomenon in vibration disease. *Cardiovasc Res* 1978;12:758-764.

[7] Ohhashi T, Azuma T, Sakaguchi M. Effect of microvibration on activity of ureteral and portal smooth muscles. *Am J Physiol* 1979;236:C192-201.

[8] FURCHGOTT RF. The pharmacology of vascular smooth muscle. *Pharmacol Rev* 1955;7:183-265.

[9] Tsai LM, Fu M, Chang CH, Hung JS. Figure-eight kinking of the aorta (pseudocoarctation) coexistent with coarctation. *Chest* 1990;97:1239-1240.

[10] Izukawa T. Kinking of the aorta with calcific aortic valve stenosis. *Thorax* 1966;21:75-78.

[11] SARIC S, VULETIC V, GVOZDANOVIC V, MARK B. A case of kinking of the aortic arch. *Circulation* 1960;21:1147-1149.

[12] Baxmann AC, Ahmed MS, Marques NC, Menon VB, Pereira AB, Kirsztajn GM, Heilberg IP. Influence of muscle mass and physical activity on serum and urinary creatinine and serum cystatin C. *Clin J Am Soc Nephrol* 2008;3:348-354.

[13] OVerhave JC, Fesler P, Ribstein J, du Cailar G, Mimran A. Estimation of renal

function in subjects with normal serum creatinine levels: influence of age and body mass index. *Am J Kidney Dis* 2005;46:233-241.

Figure legends

Figure 1: Catheterization in patients with a severely tortuous subclavian artery.

Figure 2: Aortic arch on chest X-ray. The arrows show the distance from the neck of the aortic arch to the left edge of the aortic arch.

Figure 3: A patient with a prominent pulmonary artery on chest X-ray. The arrow shows the prominent pulmonary artery.

Figure 4: Patients with post thoracoplasty status on chest X-ray.

Table1: Baseline Characteristics and Comparison of Clinical Data in Patients With and Without Severe Tortuosity

Variable	Severe Tortuosity Yes (n=48)	Severe Tortuosity No (n=96)	All Patients (n=144)	*p* Value
Age (years)	73.4±8.6	73.2±8.6	73.2±8.6	0.90
Men	19 (39.6%)	38 (39.6%)	57 (39.6%)	1.00
Height (cm)	153.0±8.7	155.0±9.5	154.3±9.3	0.21
Weight (kg) (n=143)	60.6±10.4	57.4±10.2	58.4±10.4	0.08
Body Mass Index (kg/m^2) (n=143)	26.0±4.6	23.9±3.1	24.6±3.8	<0.01*
Body Surface Area (m^2) (n=143)	1.57±0.15	1.55±0.17	1.56±0.16	0.49
Hypertension	37 (77.1%)	72 (75.0%)	109 (75.7%)	0.78
Diabetes Mellitus	15 (31.2%)	42 (43.8%)	57 (39.6%)	0.15
Hypercholesterolemia	25 (52.1%)	50 (52.1%)	75 (52.1%)	1.00
Atrial Fibrillation	5 (10.4%)	10 (10.4%)	15 (10.4%)	1.00
Malignancy	3 (6.3%)	10 (10.4%)	13 (9.0%)	0.41
Dementia	5 (10.4%)	4 (4.2%)	9 (6.3%)	0.14
History of Stroke	7 (14.6%)	12 (12.6%)	19 (13.2%)	0.75
Family History of Cardiovascular Disease	16 (33.3%)	22 (22.9%)	38 (26.4%)	0.18
Current Smoker	7 (14.6%)	7 (7.3%)	14 (9.7%)	0.16
Former Smoker	16 (33.3%)	29 (30.2%)	45 (31.3%)	0.70
Never Smoker	25 (52.1%)	60 (62.5%)	85 (59.0%)	0.23
Statin	15 (31.3%)	38 (39.6%)	53 (36.8%)	0.33
Anti Platelet Agent	29 (60.4%)	57 (59.4%)	86 (59.7%)	0.90
Angiotensin Converting Enzyme Inhibitor	5 (10.4%)	6 (6.3%)	11 (7.6%)	0.37
Angiotensin II Receptor Blocker	21 (43.8%)	41 (42.7%)	62 (43.1%)	0.91
Calcium Chanel Blocker	29 (60.4%)	50 (52.1%)	79 (54.9%)	0.34
Beta Blocker	7 (14.6%)	14 (14.6%)	21 (14.6%)	1.00
Warfarin	2 (4.2%)	6 (6.3%)	8 (5.6%)	0.61
Diuretics	6 (12.5%)	20 (20.8%)	26 (18.1%)	0.22
Stable Angina Pectoris	34 (70.8%)	59 (61.5%)	93 (64.6%)	0.27
Acute Coronary Syndrome	4 (8.3%)	10 (10.4%)	14 (9.7%)	0.69
Atypical Chest Pain	9 (18.8%)	23 (24.0%)	32 (22.2%)	0.48
Others	1 (2.1%)	4 (4.2%)	5 (3.5%)	0.52
Presence of a Significant Coronary Lesion	17 (35.4%)	47 (49.0%)	64 (44.4%)	0.12
Number of Coronary Arteries Narrowed:				
2	5 (10.4%)	17 (17.7%)	22 (15.3%)	0.25
3	2 (4.2%)	8 (8.3%)	10 (6.9%)	0.35
Left Main	0	3 (3.1%)	3 (2.1%)	0.22
Cardiothoracic Ratio (%) (n=143)	51.8±5.5	50.3±6.6	50.8±6.3	0.20
Presence of Prominently projected Aortic Arch (n=142)	26 (55.3%)	18 (19.0%)	44 (31.0%)	<0.01*
Presence of Aortic Arch Calcium (n=143)	20 (41.7%)	32 (33.7%)	52 (36.4%)	0.35

Ventricular Septal Wall Thickness (mm) (n=141)	10.3±1.5	10.5±1.6	10.4±1.6	0.60
Posterior Wall Thickness (mm) (n=141)	10.3±1.5	10.3±1.6	10.3±1.5	0.96
LV end-diastolic dimension (mm) (n=141)	46.1±4.3	44.6±5.5	45.1±5.2	0.11
LV end-systolic dimension (mm) (n=141)	26.7±5.5	27.1±6.5	27.0±6.1	0.75
Left Ventricular Mass Index (g/m^2) (n=140)	128.2±42.4	126.2±49.6	126.9±47.2	0.81
Relative Wall Thickness (n=141)	0.45±0.06	0.47±0.08	0.46±0.08	0.11
Ejection Fraction (%) (n=142)	72.5±9.9	69.2±12.1	70.3±11.5	0.10
Presence of Asynergy (n=142)	6 (12.5%)	11 (11.7%)	17 (12.0%)	0.89
E Wave to A Wave Ratio (n=119)	0.80±0.23	0.80±0.27	0.80±0.26	0.99
Left Atrial Dimension (mm) (n=139)	38.1±5.2	35.8±5.4	36.5±5.4	0.02*
Aortic Valve Annulus Dimension (mm) (n=135)	20.2±2.5	19.7±3.8	19.9±3.5	0.50
Aortic Valve Peak Velocity (m/s) (n=137)	1.17±0.86	1.02±0.72	1.07±0.77	0.31
Ankle-Brachial Index (n=124)	1.09±0.12	1.09±0.15	1.09±0.14	0.86
Pulse Wave Velocity (cm/s) (n=123)	1909±469	1911±411	1910±427	0.98
Electrocardiography: Voltage [S1+R5] (mV) (n=143)	2.53±0.84	2.52±0.95	2.52±0.91	0.92
Hemoglobin (g/dL)	13.2±2.1	13.2±1.8	13.2±1.9	0.81
Red Blood Cell Distribution Width (%)	14.7±2.6	14.4±1.5	14.5±1.9	0.33
Creatinine (mg/dL)	0.71±0.21	0.88±0.48	0.83±0.42	0.02*
Hemoglobin A1c (%) (n=137)	6.0±1.2	6.2±1.2	6.2±1.2	0.23
Total Cholesterol (mg/dL) (n=141)	205±36	202±40	203±39	0.63
LDL Cholesterol (mg/dL) (n=139)	121±36	120±33	121±34	0.92
HDL Cholesterol (mg/dL) (n=139)	54±15	52±13	52±14	0.44
LDL to HDL Ratio (n=139)	2.4±0.9	2.5±0.9	2.4±0.9	0.73
Triglycerides (mg/dL) (n=141)	145±72	137±92	139±86	0.62
Brain Natriuretic Peptide (pg/dL) (n=58)	65.7±72.5	98.8±127.6	80.0±100.4	0.22

E Wave to A Wave Ratio=Early Diastolic Filling Wave to Atrial Filling Wave Ratio, *means $p<0.05$

Table 2: Multivariate Logistic Regression Analysis

Variable	*Odds Ratio	95% CI	*p* Value
Body Mass Index	1.17	1.03, 1.33	0.02†
Presence of Prominently projected Aortic Arch	5.62	2.27, 13.9	<0.01†
Left Atrial Dimension	1.06	0.98, 1.14	0.19
Creatinine	0.05	0.01, 0.36	<0.01†

*=Per unit increment for the continuous variables, 95% CI=95% Confidence Interval, †means P<0.05.