Inter Arm Blood Pressure Difference in Patients Undergoing Coronary Angiography and Its Relationship to Coronary Artery Disease Complexity

Cibu Mathew[1], Shilpa Kannamkumarath[2], Sajna Mathumkunnath Vijayan[3], Karunadas Prabhakaran Chakkalakal[4]

[1, 4] Department of Cardiology, Government Medical College, Thrissur, Kerala, India.
[2]Department of Pulmonary Medicine, Government Medical College, Thrissur, Kerala, India.
[3]Department of Community Medicine, Government Medical College, Thrissur, Kerala, India.

ABSTRACT

BACKGROUND
Blood pressure (BP) in the right and left arms can be different. This inter arm difference (IAD) in BP can be systolic (IAD - SBP) and / or diastolic (IAD - DBP). IAD of ≥ 10 mm of Hg is considered significant. SYNTAX score is used to assess the complexity of coronary artery lesions. Prevalence of IAD in patients undergoing coronary angiography (CAG) and its relationship to complexity of coronary artery disease is unclear.

METHODS
In 100 patients taken up for CAG, BP was recorded in both the arms simultaneously with automated devices using oscillometric method. Significant IAD was defined as ≥ 10 mm of Hg. Using SYNTAX score, patients were divided into two groups; those with a lower score < 22 and those with a higher score ≥ 22. Data was analysed using SPSS version 16. Mean difference of the variables was analysed using Independent t test. Association of interarm BP difference and high SYNTAX score was analysed using Chi Square test.

RESULTS
Significant IAD of ≥ 10 mm of Hg was noted in 16 out of 100 patients. SYNTAX score of ≥ 22 was seen in 30 patients. IAD - SBP ≥ 10 was noted in 23.3 % in patients with higher SYNTAX score as against 2.9 % in those with lower score (p 0.001). IAD - DBP ≥ 10 was seen in 20 % of patients with higher SYNTAX score as against 1.4 % in those with lower SYNTAX score (p 0.001).

CONCLUSIONS
Interarm blood pressure difference of ≥ 10 mm of Hg is seen in 16 % of cases taken up for coronary angiogram. Patients with IAD ≥ 10 mm of Hg had higher SYNTAX score of ≥ 22 suggesting more complex coronary artery disease.

KEYWORDS
Interarm Blood Pressure Difference, SYNTAX Score

Corresponding Author:
Dr. Karunadas Prabhakaran Chakkalakal,
Additional Professor,
Anugraha, Chakkalakal House,
Viyyur, Thrissur, Kerala, India.
E-mail: karunadasscp@gmail.com

DOI: 10.18410/jebmh/2020/607

How to Cite This Article:
Mathew C, Kannamkumarath S, Vijayan SM, et al. Inter arm blood pressure difference in patients undergoing coronary angiography and its relationship to coronary artery disease complexity. J Evid Based Med Healthc 2020; 7(49): 2968-2973. DOI: 10.18410/jebmh/2020/607

Submission 17-08-2020,
Peer Review 24-08-2020,
Acceptance 02-10-2020,
Published 07-12-2020.

BACKGROUND

Hypertension guidelines recommend that blood pressure should be recorded in both arms because there can difference in BP between right and left arm. This interarm difference has been noted for systolic BP as well as for diastolic BP. IAD of up to 10 mm of Hg in systolic or diastolic BP is considered normal.[1] A difference exceeding 10 mm of Hg is considered to be clinically significant.[2,3] IAD exceeding 20 mm of Hg is likely to be due to a structural disease like subclavian artery stenosis.[4]

The initial description of IAD came in 1900.[5] Since then many studies have been published involving various cohorts which included people with normal BP, hypertension, peripheral arterial disease, coronary artery disease, stroke, the elderly and the young.[6,7] Many trials have been published since 2013 demonstrating the association of interarm BP differences with cardiovascular and all-cause mortality.[6]

Prevalence rates varied in these studies. Clark et al, after pooling good quality community studies, analysed the prevalence of interarm systolic BP difference of ≥ 10 mmHg. Their reported rates were 11.2 % in hypertensive cohorts, 7.4 % in diabetic cohorts and 3.6 % in the general adult population.[8] From India, Sharma et al reported interarm systolic BP difference of ≥ 10 mmHg in 5.0 % and interarm diastolic BP difference of ≥ 10 mmHg in 3.8 % of clinical outpatients.[9] In a study from Thrissur, Kerala, Seethalakshmi K reported a very high prevalence in healthy medical students; ≥ 10 mm difference was noted in 29 % of the participants.[10]

The physical and pathological basis of this difference in BP between the arms is not fully understood. The older theory was that fixed arterial stenosis of subclavian artery led to IAD and any difference above 15 mm of Hg was labelled as subclavian stenosis.[11,12] However a fixed arterial stenosis often leads to much higher values in IAD than 15 mm of Hg.[13] Many studies have looked at the relation between interarm BP difference and pulse wave velocity and demonstrated that carotid-femoral pulse wave velocity is higher in patients with IAD. Thus the "stiffness hypothesis," has emerged. The differences in brachial BP were attributed to asymmetrical or localized variations in arterial stiffness.[14,15] Arterial stiffness rather than fixed stenosis appears to be a more plausible explanation for IAD when the difference is not very high. The indirectly measured brachial BP could be decided by forward and backward reflected pulse waves which are affected in turn by vascular tone and stiffness.[16] Stiffness may develop in an asymmetric manner leading to IAD.

The correct method of eliciting IAD has not been standardized. Previous studies have used mercury manometers, aneroid manometers as well as automatic oscillometric manometers for BP measurement. Simultaneous measurement in the two arms with automated devices is recommended at present to reduce overestimation of IAD.[17,18] Serial measurement may overestimate IAD as the values can differ with time.

According to a meta-analysis, IAD - SBP ≥ 10 mm of Hg was found to be related to cerebrovascular disease, vascular damage, and increased cardiovascular mortality.[19] Patients taken up for coronary angiography are likely to have multiple cardiac risk factors as well as cardiovascular disease of varying severity. So they are likely to exhibit a higher prevalence of IAD than the general population. Some studies have shown that IAD is associated with more complex coronary artery lesions.[20] SYNTAX score, a popular system to assess the complexity of coronary artery disease, divided patients into 3 groups; low score of < 22, intermediate score of 22 to 31 and high score of > 32. Complex lesions had higher score.[21]

Studies from India assessing the relation of inter arm BP difference and complexity of coronary artery disease are lacking. Hence, we decided to undertake a study to look into the prevalence of IAD in systolic and diastolic BP in patients taken up for coronary angiogram and to look at the relation of IAD with the complexity of coronary artery disease. As a pilot study we decided to enroll 100 patients undergoing coronary angiography for this.

METHODS

This study was conducted in the Department of Cardiology, Government Medical College Hospital, Thrissur, Kerala, after approval from Institutional Ethics Committee. This was a cross sectional study involving 100 consecutive patients taken up for coronary angiogram over a period of two months from 10/05/2019 to 10/07/2019. The exclusion criteria were acute myocardial infarction, previous CAG, previous Percutaneous Transluminal Coronary Angioplasty (PTCA), previous Coronary Artery Bypass Grafting (CABG), severe valvular heart disease, congenital heart diseases, atrial fibrillation, second degree or complete heart block, Cerebro-Vascular Accident (CVA), limb deformity or amputation and established peripheral vascular disease. Informed consent was obtained from patients.

Demographic variables, handedness (right or left) and the following were noted;[1] treatment for hypertension[2] treatment for diabetes or FBS value > 126 mg / dL,[3] treatment for dyslipidaemia or in hospital total cholesterol > 200 mg / dL and / or LDL > 160 mg / dL,[4] history of smoking in last year and[5] left ventricular hypertrophy in echocardiography. If BMI was equal to or exceeded 23 it was considered as overweight / obese.

BP was recorded as per ACC guidelines 2018 by a doctor or a staff nurse trained in the proper method using automated oscillometric recorders in both the arms simultaneously between 3 pm and 5 pm on the day of admission and coronary angiogram was done on the next day. The time of recording was chosen like this to avoid the immediate effects on BP of medications for hypertension which were being taken either in the morning or at bedtime. Three sets of BP readings were taken 5 minutes apart. The average of the three readings was taken as the patient's BP in each arm. The difference between the averaged systolic BP of right arm and left arm was noted as IAD - SBP. The difference between the averaged diastolic BP of right arm and left arm was noted as IAD - DBP. A difference of ≥ 10

mm of Hg was taken as significant IAD for both systolic and diastolic BP.

Coronary angiogram of each patient was analysed and SYNTAX scoring done by the two investigators separately. The average of the two scores was taken as the patient's score. A score < 22 was categorized as lower score for this study. A score ≥ 22, which included intermediate (22 - 32) and high (33 or more) scores in the SYNTAX trial, was categorized as higher score.

Data was analysed using SPSS version 16. Qualitative data was analysed using proportions. Quantitative data was analysed using mean and standard deviation. Mean difference of the variables was analysed using independent t test. Association of interarm BP difference with high SYNTAX score and other variables was analysed using chi square test. Using multilogistic regression analysis, association of variables to SYNTAX score was assessed. The level of significance was kept at 5 %.

RESULTS

100 patients undergoing coronary angiography after the exclusion criteria were studied. The mean age was 56 years, mean height 1.59 meters, mean weight 60.4 kg and mean BMI 23.6. Males constituted 72 %. Right hand dominance was seen in 97 %. Hypertension was present in 55 %, diabetes in 47 % and smoking in 42 % cases. Echo showed left ventricular hypertrophy in 28 % cases. (Table 1)

Variables	Value
Age in Years (mean ± SD)	56.48 ± 9.1
Height in Meters (mean ± SD)	1.59 ± 0.09
Weight in Kilograms (mean ± SD)	60.38 ±10.59
BMI (mean ± SD)	23.61 ± 3.03
Sex (male) (%)	72 (72 %)
Right Hand Dominance (%)	97 (97 %)
Hypertension (%)	55 (55 %)
Diabetes (%)	47 (47 %)
Smoking (%)	42 (42 %)
Left Ventricular Hypertrophy on Echo (%)	28 (28 %)
IAD-SBP ≥ 10 mmHg (%)	9 (9 %)
IAD-DBP ≥ 10 mmHg (%)	7 (7 %)
Lower SYNTAX Score (< 22) (%)	70 (70 %)
Higher SYNTAX Score (≥ 22) (%)	30 (30 %)

Table 1. Clinical Characteristics of Patients

IAD ≥ 10 mmHg in BP was noted in 16 out of 100 patients; IAD - SBP in 9 and IAD - DBP in 7. No single patient had significant IAD in both systolic and diastolic BP. The number of patients in various ranges of IAD is given in table 2.

BP Difference (mm of Hg)	No. of Patients Systolic	No. of Patients Diastolic
0	8	14
1 – 4	50	56
5 - 9	33	23
≥ 10	9	7

Table 2. Distribution of Patients in Various IAD Ranges

In patients who showed IAD more than 10 mm of Hg, the mean difference in interarm systolic blood pressure was 12.1 (SD ± 2.80) mm of Hg and the mean difference in interarm diastolic blood pressure was 12.7 (SD ± 2.98) mm of Hg.

In the group with significant IAD (systolic and diastolic put together) there was more hypertension and left ventricular hypertrophy on echo though not statistically significant. But diabetes and smoking were less in this group. IAD was not associated with handedness. The association of clinical variables with significant IAD is given in Table 3.

Variable	No. Significant IAD (84)	Significant IAD (16)	P Value
Hypertension	46 (54.8 %)	9 (56.3 %)	0.83
Diabetes	40 (47.6 %)	7 (43.8 %)	0.77
Smoking	36 (42.9 %)	6 (37.5 %)	0.69
LVH	23 (27.4 %)	5 (31.2 %)	0.75
Dominant right hand	97.6 %	93.8 %	0.41

Table 3. Association of Clinical Variables with Significant IAD

No.	Variable	Total Number	Low Syntax Group (N = 70)	High Syntax Group (N = 30)	P Value
1	HTN	55	37 (52.9 %)	18 (60.0 %)	0.244
3	Diabetes	47	31 (44.3%)	16 (53.3 %)	0.205
2	Smoking	42	29 (41.4 %)	13 (43.3 %)	0.213
4	LVH on Echo	28	17 (24.3 %)	11 (36.7 %)	0.206
5	IAD - SBP	9	2 (2.9 %)	7 (23.3 %)	0.001
6	IAD – DBP	7	1 (1.4 %)	6 (20 %)	0.001

Table 4. Association of Clinical Variables with SYNTAX Score

On angiographic analysis of the 100 cases a lower SYNTAX score of < 22 was seen in 70 cases and a higher score ≥ 22 in 30 cases. SYNTAX scores ranged from 0 to 58.5. In the lower SYNTAX score group of 70 patients, 9 had score of zero. In the higher SYNTAX score group of 30 patients, 19 had a score less than 32. Of the 7 patients with significant IAD - SBP in the higher SYNTAX score group only one patient had score above 32. Similarly, among the 6 patients with significant IAD - DBP in the higher SYNTAX group only one had score above 32.

IAD - SBP < 10 mm of Hg was seen in 91 patients out of which 23 (25.3 %) had a higher SYNTAX score. IAD - SBP ≥ 10 mm of Hg was seen in 9 patients out of which 7 (77.8) had a higher SYNTAX score. IAD - DBP < 10 mm of Hg was seen in 93 patients out of which 24 (25.8 %) had a higher SYNTAX score. IAD - DBP ≥ 10 mm of Hg was seen in 7 patients out of which 6 (85.7 %) had a higher score. Of the 30 patients with higher SYNTAX score 7 patients (23.3 %) showed significant IAD - SBP and 6 patients (20 %) showed significant IAD - DBP. Of the 70 patients with lower SYNTAX score only 2 patients (2.9 %) showed significant IAD - SBP and only 1 patient (1.4 %) showed significant IAD - DBP (p 0.001)

The analysis of the association of clinical variables and SYNTAX score showed higher number of patients with hypertension, diabetes, smoking and LVH in the group with higher SYNTAX score though none was statistically significant. Only IAD correlated with higher SYNTAX scores (Table 4). Multilogistic regression analysis showed that age and interarm BP difference both systolic and diastolic were independently associated with a higher SYNTAX score (Table 5).

Factors	B	S.E.	Sig.	Exp (B)
Smoking	- .653	.636	.304	.520
Diabetes	1.038	.594	.081	2.823
LVH	.934	.609	.125	2.545
HTN	- .167	.656	.799	.846
IAD - SBP	- 2.592	.929	.005	.075
IAD - DBP	- 4.550	1.346	.001	.011
Age	- .080	.035	.021	.923

Table 5. Multilogistic Regression Analysis of Factors Associated with Higher SYNTAX Score

The analysis of relation of a combination of hypertension and IAD to SYNTAX score showed no significant difference. However, when the combination of overweight / obese and IAD and SYNTAX score was analysed significant difference was noted. Overweight / obese group had higher SYNTAX scores if associated IAD was there (Table 6)

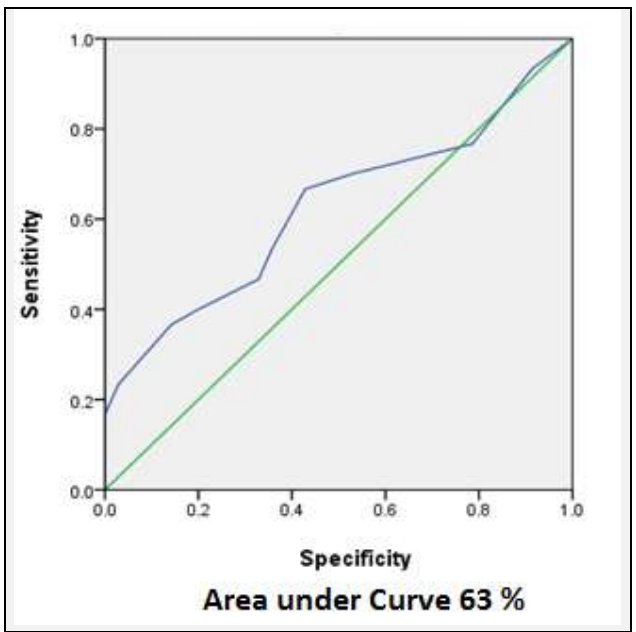

Figure 1. Relation of IAD-Systolic with High SYNTAX Score

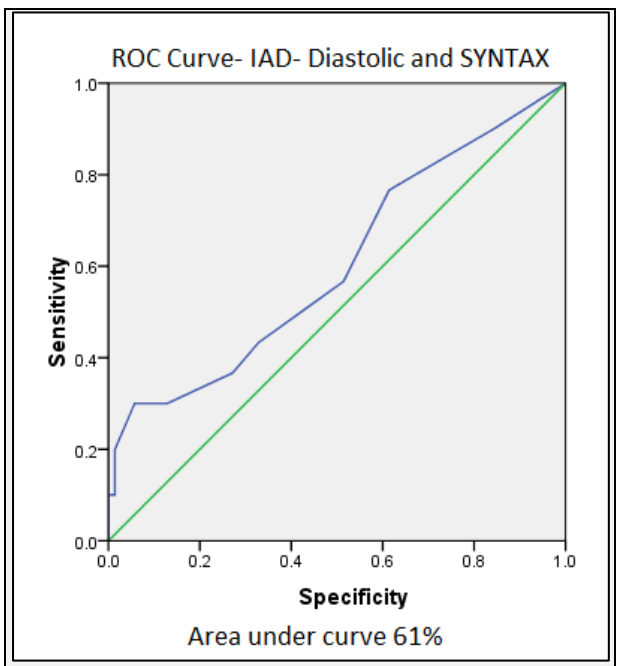

Figure 2. Relation of IAD-Diastolic with High SYNTAX Score

Variable	Total Number	High SYNTAX	Low SYNTAX	p Value
Hypertension with IAD	10	9 (90 %)	1 (10 %)	
Hypertension without IAD	6	3 (50 %)	3 (50 %)	0.23
Obesity	60	15 (25 %)	45 (75 %)	
Non obese	40	15 (37.5 %)	25 (62.5 %)	0.18
Obesity + IAD	11	8 (72.7 %)	3 (27.3 %)	
Obesity + No IAD	49	7 (14.3 %)	42 (85.7 %)	0.0002
Non obese + IAD	5	5 (100 %)	0	
Non obese+ No IAD	35	10 (28.5 %)	25 (71.4 %)	0.009

Table 6. Association of Combination of Hypertension or Overweight / Obesity to SYNTAX Scores

DISCUSSION

Hypertension guidelines recommend recording BP in both the arms initially and then using the arm with the higher value for follow up. Inter-arm blood pressure difference (IAD) is considered significant if it is ≥ 10 mm of Hg. Significant IAD has been found to be related to CVA vascular damage, and increased cardiovascular mortality.[19] There have been results linking significant IAD to the severity of coronary artery lesions as well as the structure and content of atheromatous plaques.[22,23] Measurement of Ankle Brachial Index (ABI) is recommended in hypertensive patients as a marker of vascular disease. ABI correlated with the extent of coronary artery disease and the post-PCI prognosis regardless of the SYNTAX score.[22] IAD measurement is simpler than ABI and can be applied to all patients easily.

In our study significant IAD was found in 16 % undergoing coronary angiography. The difference was noted in systolic BP in 9 patients and in diastolic BP in 7 patients. This prevalence rate is a little higher when compared to the pooled prevalence rates proposed by Clark for various cohorts; 11.2 % for hypertensive cohorts, 7.4 % for diabetic cohorts and 3.6 % for general adult population. Our population was patients taken up for coronary angiography with multiple cardiac risk factors. This could have led to the higher number of patients with IAD that we found. Previous studies have shown that there can be overestimation of IAD if recording is done serially i.e. first on one arm and then on the other arm due to the "white coat" effect as well as the variability in BP and heart rate from time to time. But we used the simultaneous method of recording and so this error is unlikely. In a study by Gurmus et al where the simultaneous method of BP recording was done in patients taken up for coronary angiography significant IAD defined as ≥ 10 mm of Hg was noted in 16 out of 104 cases (15.4 %) a value similar to ours.[20] A single set of reading has been found to overestimate IAD than multiple readings. Many previous studies recorded three sets of BP and having found the average, calculated IAD by subtracting the lower value from higher one. We also followed the same pattern of three sets of readings.

Some previous studies had shown that the dominant hand can have a higher BP value. There were 3 patients who were left-handed in our study. In all the three, BP was higher on right arm, but the difference was not significant. Hence, we found no association of IAD with handedness.

We could not find any association of IAD with other clinical risk factors of CVD like hypertension, diabetes, smoking or left ventricular hypertrophy on echo (Table 2). From Portugal a study had been published regarding IAD in 2000 hypertensive patients.[24] Different ranges of IAD was noted according to the grades of hypertension. Inter arm differences of systolic BP classes were respectively 1.71 ± 2.00 mmHg, 2.05 ± 7.60 mmHg, 3.51 ± 09.70 mmHg, 6.40 ± 13.81 mmHg and 8.80 ± 18.70 mm of Hg, for normal BP, normal-high BP, grade 1, grade 2 and grade 3 hypertension. The distribution was similar for diastolic BP. In other words, IAD of 10 mm was seen more often in grade 3 hypertension (> 180 / 110). Their analysis revealed a steady increase in IAD to increasing levels of BP. Our patients taken up for coronary angiogram had controlled or only marginally elevated blood pressures. This could be the reason why an association of HTN with IAD was not seen in our study. In a study from Korea, it was found that if the mean systolic BP was higher there was more chance of picking up IAD of 10 mmHg or more.[25] The only other clinical variable that correlated with significant IAD in the above study was higher CRP levels apart from higher mean systolic BP. Diabetes or smoking showed no significant association with IAD of ≥ 10 mm of Hg.[25] We did not look at the CRP levels. Most of our patients had well controlled BP and blood sugars and most of them were not smoking currently as they were being taken up for coronary angiogram. This could be the likely reason of not finding any association for these factors with significant IAD.

SYNTAX - The Synergy between PCI with TAXUS and Cardiac Surgery score is used to assess the complexity of coronary artery lesions.[21] In the SYNTAX trial depending on score there were 3 groups, low score (< 22), intermediate score (22 - 32) and high score (33 or more). A score of less than 22 meant less complex coronary artery disease. We chose this score as the cut off point for comparison of IAD and complexity of coronary artery disease. Patients with significant IAD more often showed SYNTAX scores of ≥ 22 indicating that their coronary artery lesions were more complex.

From Turkey Gurmus et al reported similar result as to our study.[20] They studied 104 patients undergoing coronary angiography. IAD was defined as ≥ 10 mm of Hg. The complexity and extent of coronary lesions was assessed using SYNTAX score. A score of < 20 was considered low while a score of ≥ 20 was high. In the group with a high SYNTAX score (≥ 20) the mean IAD values were significantly higher. The patients with IAD ≥ 10 had high SYNTAX score compared to the patients with IAD < 10. The conclusion of this study was that "The IAD values obtained by only blood pressure measurements are closely related to the extent of coronary artery disease". In a larger study from Japan 1013 patients taken up for coronary angiogram were studied for IAD.[26] Gensini score was used for assessing complexity of coronary lesions. Mean IADs were significantly greater in patients with CAD than in those without it. Gensini scores were significantly higher in those with high IAD (≥ 10 mmHg) than in those with low IAD. Patients with high IAD had a significantly greater probability of cardiovascular events. Patients with high IAD and peripheral artery disease had the highest Gensini scores.

Our study results were similar. Those patients with significant IAD had higher SYNTAX scores of ≥ 22 and more patients exhibited significant IAD in the group with higher SYNTAX scores. Of the 7 patients with significant IAD - SBP in the higher SYNTAX score group only one patient had score above 32. Similarly, among the 6 patients with significant IAD - DBP in the higher SYNTAX group only one had score above 32. This could indicate that as coronary lesions become very advanced the BP difference comes down probably because of advanced atherosclerosis becoming equal in both arms. Multilogistic regression analysis showed that age and IAD - SBP and IAD - DBP were the only factors significantly associated with a higher SYNTAX score.

Limitations of the study

Our study is a single centre study with small number of patients. We did not do a routine radiological evaluation for the aorta and its branches in those with IAD ≥ 10 mmHg to exclude subclavian stenosis.

CONCLUSIONS

Our study used simultaneous measurement of BP of both upper limbs using oscillometric method. In patients undergoing coronary angiogram, 16 % had significant interarm blood pressure difference of ≥ 10 mmHg. Those patients with significant IAD are likely to have SYNTAX score of ≥ 22 indicating more complex coronary artery lesions.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.
Financial or other competing interests: None.
Disclosure forms provided by the authors are available with the full text of this article at jebmh.com.
Authors thank Ms. Aruna Elizebeth Kuriakose and Ms. Ambily Melethody, Cath Lab Technicians of Govt. Medical College, Thrissur for recording angiograms and helping in calculating SYNTAX score.

REFERENCES

[1] Orme S, Ralph SG, Birchall A, et al. The normal range for inter-arm differences in blood pressure. Age and Ageing 1999;28(6):537-542.
[2] Clark CE, Campbell JL, Evans PH, et al. Prevalence and clinical implications of the inter-arm blood pressure difference-a systematic review. J Hum Hypertens 2006;20(12):923-931.
[3] Lane D, Beevers M, Barnes N, et al. Inter-arm differences in blood pressure: When are they clinically significant? Journal of Hypertension 2002;20(6):1089-1095.
[4] Huibers A, Hendrikse J, Brown MM, et al. Upper Extremity blood pressure difference in patients undergoing carotid revascularisation. Eur J Vasc Endovasc Surg 2017;53(2):153-157.

[5] Clark CE. Difference in blood pressure measurements between arms-methodological and clinical implications. Curr Pharm Des 2015;21(6):737-743.
[6] Clark CE. The interarm blood pressure difference: Do we know enough yet? J Clin Hypertens (Greenwich) 2017;19(5):462-465.
[7] Clark CE. Difference in blood pressure between arms might reflect. Peripheral vascular disease. BMJ 2001;323(7309):399.
[8] Clark CE, Taylor R, Shore AC, et al. Prevalence of systolic inter-arm differences in blood pressure varies for different primary care populations: systematic review and meta-analysis. Br J Gen Pract 2016;66(652):e838-e847.
[9] Sharma B, Ramawat P. Prevalence of inter-arm blood pressure difference among clinical out-patients. Int J Health Sci (Qassim) 2016;10(2):229-237.
[10] Seethalakshmi K, Bahuleyan B. Inter-arm blood pressure difference: an indicator of cardiovascular risk. Int J Res Med Sci 2015;3(12):3782-3785.
[11] Aboyans V, Kamineni A, Allison MA, et al. The epidemiology of subclavian stenosis and its association with markers of subclinical atherosclerosis: The Multi-Ethnic Study of Atherosclerosis (MESA). Atherosclerosis 2010;211(1):266-270.
[12] Aboyans V, Criqui MH, McDermott MM, et al. The vital prognosis of subclavian stenosis. J Am Coll Cardiol 2007;49(14):1540-1545.
[13] Baribeau Y, Westbrook BM, Charlesworth DC, et al. Brachial gradient in cardiac surgical patients. Circulation 2002;106(12 Suppl 1):11-13.
[14] Canepa M, Milaneschi Y, Ameri P, et al. Relationship between inter-arm difference in systolic blood pressure and arterial stiffness in community-dwelling older adults. J Clin Hypertens (Greenwich) 2013;15(12):880-887.
[15] Giles TD. Inter-arm difference in systolic blood pressure -"the plot stiffens." J Clin Hypertens (Greenwich) 2013;15(12):878-879.
[16] Salvi P. Pulse Waves: How vascular hemodynamics affects blood pressure? 2012th edn. Springer 2012.
[17] Verberk WJ, Kessels AGH, Thien T. Blood pressure measurement method and inter-arm differences, a meta-analysis. Am J Hypertens 2011;24(11):1201-1208.
[18] Omboni S, Verberk WJ. Simultaneous double arm automated blood pressure measurement for the screening of subjects with potential vascular disease: a community study. Blood Pressure 2018;28(1):15-22.
[19] Clark CE, Taylor RS, Shore AC, et al. Association of a difference in systolic blood pressure between arms with vascular disease and mortality: a systematic review and meta-analysis. The Lancet 2012;379(9819):905-914.
[20] Durmus G, Belen E, Bayyigit A, et al. The relationship between inter-arm blood pressure difference and coronary artery disease severity calculated by SYNTAX score. Int J Hypertension 2018;2018:9370417.
[21] Serruys PW, Morice MC, Kappetein AP, et al. Percutaneous coronary intervention versus coronary-artery bypass grafting for severe coronary artery disease. NEJM 2009;360(10):961-972.
[22] Ueki Y, Miura T, Miyashita Y, et al. Predictive value of combining the ankle-brachial index and SYNTAX score for the prediction of outcome after percutaneous coronary intervention (from the SHINANO Registry). American Journal of Cardiology 2016;117(2):179-185.
[23] Iannaccone M, Quadri G, Taha S, et al. Prevalence and predictors of culprit plaque rupture at OCT in patients with coronary artery disease: a meta-analysis. European Heart Journal Cardiovascular Imaging 2016;17(10):1128-1137.
[24] Pereira T, Maldonado J. A study of inter-arm blood pressure differences in a cohort of 2000 hypertensive patients. Journal of Hypertension 2016;34:e361.
[25] Song BM, Kim HC, Shim J, et al. Inter-arm difference in brachial blood pressure in the general population of Koreans. Korean Circ J 2016;46(3):374-383.
[26] Takanori T, Eiichiro Y, Yoshihiro H, et al. Relationship between inter-arm blood pressure differences and future cardiovascular events in coronary artery disease. Journal of Hypertension 2015;33(9):1780-1790.