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The use of ankle brachial pressure indices in a cohort of black African diabetic patients

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ABSTRACT

Background: Peripheral arterial disease is very common in patients with diabetes, but it remains grossly under-recognized in this type of patients. Ankle brachial index (ABI) is a simple, non-invasive and reproducible method for detection and improving risk stratification. However, the sensitivity appears to be lower in diabetic patients and, false 'high' readings occur because of the arterial calcification of the vessel media which render the vessels incompressible.

Materials and methods: The study evaluated the prevalence of a low ABI < 0.9 in diabetic patients in a hospital-based cross sectional observational study. The study has been registered.

Results: The prevalence of peripheral arterial disease in diabetics with ABI < 0.9 was 18%. The majority (77%) of responders were asymptomatic with mild PAD (ABI 0.7–0.9). Age > 60 years, hypertension (systolic BP > 140 mmHg) and presence of foot ulcer were identified as independent risk factors. 22 participants (4.4%) of the 500 had ABI greater than 1.3 but were excluded in the analysis.

Conclusion: The prevalence of PAD in diabetics measured by the ABI index was low and the majority in our setting had mild PAD and were asymptomatic. ABI could be used in patients with diabetes, but values should be interpreted with precision, according to the clinical situation as higher values are common.

1. Introduction

It is estimated that 170 million individuals have diabetes in the world and it is projected to rise to 360 million by 2030 [1]. Atherosclerotic vascular disease is probably present in all patients with long duration diabetes, and, is responsible for up to 70% of deaths in non-insulin dependent diabetes mellitus (NIDDM) [1,2]. In addition to diabetes accelerating atherosclerosis, the premenopausal protection from vascular disease is lost in female diabetic patients and peripheral vascular disease may be 20 times more common in diabetes [2] Although PAD is very common in patients with diabetes, it remains grossly under-recognized in this population because neuropathy masks the pain of intermittent claudication [3]. PAD is associated with a high risk of lower extremities amputation and an important marker of generalize atherosclerosis. It has a linear relationship with coronary artery disease [4]. The same risk factors also operate and include smoking, hypertension, dyslipidaemia, abnormal fibrinolysis and altered platelet function [5,6]. Doppler-derived arterial pressure measurements should confirm the presence of arterial disease. The Ankle brachial index (ABI) is the ratio of the ankle systolic pressure to the brachial systolic pressure which is 1.0 or more in normal subjects [7,8]. A low ABPI also indicate a significantly raised relative risk of death from cardiovascular disease [9]. However, the degenerative dystrophic calcification of the media especially common in the major lower limb arteries of the elderly and in patients with diabetes cause false 'high' readings. In these patients toe pressure measurements may be of value [10].

Africa has the lowest rate of diabetes but has the highest rate of undiagnosed patients and thus complications. The prevalence of diabetes is 5.7% in urban Cameroon, W/Africa, but 70% of the population remain undiagnosed [11,12]. In addition, the progression of asymptomatic peripheral arterial disease to claudication has been less widely studied. In the Edinburgh Artery study 15% of those with major, and 7% of those with minor asymptomatic disease developed intermittent claudication in a five-year period [13]. Despite the 'false' high readings with diabetics, the objective of our study was to evaluate the relationship between ABI and cardiovascular (CVS) risk factors in a hospital cohort of adult patients with diabetes. The aim was to evaluate the prevalence and implications of a low ABI < 0.9 in an African diabetic population, and the associated risk factors.

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2. Methods

A hospital-based cross-sectional observational study of diabetic patients aged 20 years and above, was carried out in the National Centre for diabetes and hypertension of the Yaounde Central hospital in Cameroon, W/Africa between January and March 2016. The minimum sample size was obtained from the Cochrane formula [14]: ($N = z^2 p(1-p)/d^2$) where n is estimated sample size; z is the standard normal variate and for 95% confidence interval it is 1.96; p is the prevalence of PAD in patients with CVS risk factors at the Yaounde General Hospital 2014 reported by Menangal et al. [15] as 16.7%; d the tolerated sampling error (5%). Using the above formula, n (1.96)2 (0.167)(0.833)/(0.05)2 the minimum sample size was 214 diabetic patients. A convenient consecutive non-probability sampling method was used to enroll those who met the inclusion criteria for the study. The inclusion criteria were 1) patients above 20 years with diabetes and being followed up for at least 12 months, 2) those who consented to the study. The exclusion criteria were 1) those who had deep vein thrombosis (DVT) diagnosed by a positive Homan's sign or a history of DVT, 2) patient who had undergone vascular surgery to lower limbs, 3) those with diagnosed vascular disease, 4) severe terminally ill patients who could not tolerate the ABI measurement procedures, 5) those who did not consent to the study. Of the 510 diabetic patients approached, 7 patients who denied consent and 3 deep vein thrombosis (DVT) patients were excluded from the study. Ankle Brachial pressure Index (ABI) measurements were done for all patients. To measure the Doppler ankle pressure, a sphygmomanometer cuff placed around the ankle was inflated to a suprasystolic level and then slowly deflated. The onset of blood flow detected by the Doppler probe equals the systolic blood pressure. Both the posterior tibial and dorsalis pedis arteries were interrogated and the highest pressure noted. If neither was heard a search was made for the peroneal artery behind the fibula or around the lateral malleolus. ABI values were categorized into three groups; (a) those with ABI < 0.9 were considered as having PAD, (b) those with ABI > 0.9 but < 1.3 were considered as having normal ABI and thus no PAD, (c) those with ABI > 1.3 were considered as having incompressible vessels and excluded from the analysis as required further investigations such as the toe-brachial index. 22 (4.4%) patients with ABI > 1.3 were excluded from further analysis. 478 patients with diabetes were administered a pretested questionnaire containing socio-demographic, clinical and paraclinical characteristics. The mean age of participants was 59 years and majority were of the female gender (65%). 99% of participants had type 2 diabetes and the mean duration of diabetes was 8 years. Cardiovascular risk factors were evaluated in all participants. Fasting blood sugar and urinalysis for proteinuria were performed. HbA1c, creatinine, HDL-cholesterol, LDL-cholesterol, total cholesterol and triglyceride levels were noted from the patients' files. The Edinburgh's Claudication Questionnaire (ECQ) [16] was administered to those with ABI < 0.9 and 106 patients responded (Table 3). A data entry form was created in EPI-INFO version 7.0. The data was analyzed using 95% confidence interval with a P-value of 0.05 considered statistically significant. The study has been registered.

3. Results

Using a cut of value of ABI < 0.9, out of 478 participants in the analysis, 86 had ABI < 0.9 giving a prevalence of 18%. Of the 106 who responded to the Edinburgh claudication questionnaire 77% were asymptomatic with mild PAD (ABI 0.7–0.9). 23% reported claudication (Table 3) (14% below the knee, 6% above the knee (thigh) and 3% both above and below the knee). 37 (22%) males and 49 (16%) females had PAD as determined by the ankle-brachial index (ABI). In the bivariate analysis using a simple Chi square, PAD was associated with aging (p = 0.033), ethnicity (P 0.04), duration of diabetes (p = 0.006), past history of hypertension (p 0.009), history of MI (p = 0.022), presence of foot ulcers (p= 0.004), high systolic blood pressure (p = 0.011), visceral obesity (p = 0.001), proteinuria (p= 0.001), low levels of HDLc (p < 0.001) and high levels of LDLc (p = 0.022) (Tables 1, 4–7). In multivariate analysis using logistic regression, PAD was independently associated with age > 60 years (p = 0.004), OR 2.03, CI: 1.24–3.34), presence of foot ulcers (p = 0.002, OR 12.03, CI: 2.29–63.13) and systolic BP > 140 mmHg (p = 0.005, OR 1.96, CI: 1.21–3.16) (Table 2). 22 (4.4%) participants of the 500 had ABI greater than 1.3 and were excluded in the analysis.

Table 1
Bivariate analysis of socio-demographic risk factors for PAD.

	PAD n (%)	NON-PAD n (%)	TOTAL	P-Value
Age				
> 60	59 (68.60)	203(51.79)	262(54.81)	**0.033**
< 60	27(31.40)	189(48.21)	216(45.19)	
Gender				
Male	37 (43.02)	128(32.65)	165(34.52)	0.619
Female	49 (56.98)	264(67.35)	313(65.48)	
Occupation				
Unemployed	67 (77.91)	295(75.26)	362(75.10)	0.809
employed	19(22.09)	97(24.74)	116(24.90)	
Educational level				
High	52(60.47)	200(51.02)	252(52.72)	0.820
Low	34(39.53)	192(48.98)	226(47.28)	
Ethnicity				
Coastal tropical forest people	8(9.30)	25(6.38)	33(6.9)	**0.040**
Others	78(90.70)	367(93.62)	445(93.10)	

Bold indicates statistically significant p-value.

Table 2
Logistic regression of risk factors of PAD.

Risk Factor	p-value	95% Confidence interval	Odds Ratio
Age(≥60 vs. < 60 years)	*0.004*	*1.23–3.34*	*2.03*
Ethnicity coastal tropical forest people vs. Others	0.625	0.4–3.14	0.083
Duration of Diabetes (≥10 vs. < 10 years)	0.234	1.01–5.21	1.70
Past History of Hypertension (Yes vs No)	0.737	3.24–10.52	4.42
Myocardial Infarction (Yes vs No)	0.999	1.67–8.21	2.3
Presence Of Foot Ulcer(s) (Yes vs No)	**0.0002**	**2.29–63.13**	**12.03**
Taking Antiplatelet drugs (Yes vs No)	0.084	0.32–2.11	0.54
Systolic BP(mmHg) (≥140 vs < 140 mmHg)	**0.005**	**1.21–3.16**	**1.96**
Visceral Obesity (Yes vs No)	0.761	1.04–3.92	2.10
Creatinine (> 1.2 vs ≤ 1.2 mg/dL)	0.778	0.21–3.1	0.65
Proteinuria (Yes vs No)	0.061	1.42–4.60	2.55
HDLc (< 50 vs ≥ 150 mg/dL)	0.899	0.64–1.32	0.92
LDLc (> 100 vs ≤ 100 mg/dL)	0.498	2.23–9.52	5.10

Bold indicates statistically significant p-value.

Table 3
The Rutherford classification of participants with PAD.

Grade	Categories/ stages/ABI	Description	Number of participants	Percentage (%)
0	0 (ABI 0.91–1.3)	asymptomatic	66	76.64
1		Claudication	20	23.26
	1(ABI 0.70–0.9)	Mild(> 200 m)	16	80
	2(ABI 0.40–0.69)	Moderate (100–200 m)	4	20
	3(ABI < 0.4)	Severe (< 100 m)	0	0
II	4	Rest pain	0	0
III	5	Minor tissue loss	0	0
IV	6	Major tissue loss	0	0

Table 4
Bivariate analysis of clinical characteristics of PAD.

	PAD n(%)	No PAD n(%)	TOTAL	P- Value
Past diagnosis of hypertension				
YES	56(65.12)	216(55.10)	272(56.90)	0.009
NO	30(34.88)	176(44.96)	206(43.10)	
Dyslipidemia				
YES	20(23.26)	69(17.60)	89(18.62)	0.714
NO	66(76.74)	“é”(82.40)	389(81.38)	
CKD				
YES	5(5.84)	13(3.32)	18(3.77)	0.158
NO	81(94.19)	379(96.65)	460(96.32)	
HIV				
POSITIVE	1(1.16)	9(2.30)	10(2.09)	0.665
Neg/no idea	85(98.84)	383(97.70)	468(97.91)	

Table 5
Bivariate analysis of clinical characteristics of PAD continued.

	PAD n(%)	No PAD n(%)	TOTAL	P- Value
SMOKING				
smoked	16(18.60)	47(11.99)	63(13.18)	0.752
Never smoked	70(81.40)	345(88.01)	415(86.82)	
Chewing tobacco				
Yes	4(4.65)	10(2.55)	14(2.93)	0.944
No	82(95.35)	382(97.45)	464(97.07)	
Alcohol Abuse (> 21 units for males or > 14 units for female)				
Yes	7(8.14)	15(3.83)	22(4.60)	0.364
No	79(91.86)	377(çè.17)	456(93.40)	
Oral contraception				
Yes	10(11.63)	29(7.40)	39(8.16)	0.318
No	76(88.37)	363(92.62)	439(91.84)	
Myocardial infarction				
Yes	4(4.65)	3(0.77)	7(1.46)	0.022
No	82(95.35)	389(99.23)	471(98.54)	

Table 6
Bivariate analysis of clinical characteristics of PAD continued.

	PAD n(%)	No PAD n(%)	TOTAL	P- Value
Stroke				
Yes	5(5.81)	3(0.77)	8(1.67)	0.885
No	81(94.19)	390(99.23)	470(98.33)	
Presence of foot ulcers				
Yes	5(5.81)	2(0.51)	7(1.46)	0.041
No	81(94.19)	390(99.49)	471(98.54)	
On Antiplatelet drug				
Yes	16(18.60)	27(6.89)	43(9.0)	0.001
No	70(81.40)	365(93.11)	435(91.0)	
Family history of PAD				
Yes	3(3.49)	12(3.1)	15(3.14)	0.764
No	83(96.51)	308(96.9)	463(96.86)	

4. Discussion

The study demonstrated a prevalence of PAD in 18% of a large cohort of black African diabetic patients using Doppler Ankle brachial index (ABI) measurements. 99% of participants had type 2 diabetes and the mean duration of diabetes was 8 years. This was closely similar to a prevalence of 16.7% in patients with cardiovascular risk factors reported by Menanga et al. in the same setting although just 5 out of the 42 participants were diabetics [15]. Studies in Uganda and Nigeria on diabetic patients with advanced age showed a prevalence of 39% and 52.5% respectively [17,18]. In this study the majority (77%) were asymptomatic with mild PAD. Age > 60 years, hypertension (systolic BP > 140 mmHg) and presence of foot ulcer were identified as independent risk factors. Several studies have shown that ABI has a sensitivity of 95% and specificity of 100% [19]. A positive predictive value of 90%, a negative predictive value of 99% and an overall

Table 7
Bivariate analysis of clinical characteristics of PAD Continued.

	PAD n(%)	No PAD n(%)	TOTAL	P- Value
Urinalysis (Presence of proteinuria)				
Yes	31(36.05)	77(19.64)	108(22.59)	0.001
No	55(63.95)	315(80.36)	370(77.41)	
Total Cholesterol (mg/dL)				
> 200	12(13.95)	49(21.40)	61(19.37)	0.183
≤200	74(86.05)	180(78.60)	254(80.63)	
HDLc(mg/dL)				
> 50	13(15.12)	114(49.78)	127(40.32)	< 0.001
≤50	73(84.88)	115(50.22)	188(59.68)	
LDLc(mg/dL)				
> 100	29(33.72)	110(48.06)	139(44.13)	0.022
≤100	57(66.28)	119(51.94)	176(55.87)	
TG(mg/dL)				
> 150	13(15.12)	40(12.47)	53(16.83)	0.619
≤150	73(84.88)	189(12.47)	262(83.17)	

accuracy of 98% favour the use of ABI as a screening test or a diagnostic tool in non-diabetics [20–23]. If Doppler ankle pressures are normal in a patient with a good history of claudication, the sensitivity of the test is increased after exercise on a treadmill for 1 min [24]. Unfortunately, it remains a problem in the diabetic patient with evidence of both arterial occlusive disease and neurological symptoms. In addition, apart from being diagnostic, ABI values reflect the severity of PAD (Tables 3 and 8) [7,8,20,25], making it a widely used marker for the presence and progression of PAD in major cardiovascular trials [26–32]. Normal subjects should have an ABI of 1.0 or more, whereas in claudicants it is usually less than 0.9. Critical ischaemia has been defined by the European working group as persistent rest pain for more than 2 weeks and/or ulceration or gangrene, plus an ankle systolic pressure of less than 50 mmHg (ABI < 0.5) [33] (Tables 3 and 8). Calcification of the arterial media which is common in diabetes, may lead to falsely elevated pressures greater than 1.3 due to incompressible arteries. However, an experienced operator will be alerted by the damped flow signals if proximal disease is present (waveform analysis) [34]. Toe (digital) arteries are less likely to be affected by calcification but require small cuffs and are more difficult to measure routinely. However, a toe-brachial index (TBI) measurement may be of value, and toe and/or oxygen pressures have been shown to enhance the detection of critical ischaemia [8]. The prevalence of a low or falsely elevated (pathological ABI) is high in diabetic subjects with symptomatic peripheral vascular disease and frequently associated with diabetic neuropathy (possibly ischaemic in cause) and chronic renal failure (CRF) [35–38] It relates with age, duration of diabetes and the presence of vascular disease in another vascular bed [22,37–39]. In addition, an ABI > 1.3 in CRF is frequently associated with hyperparathyroidism, suggesting a possible role of the disturbances in calcium and phosphorus metabolism in the occurrence of media calcification [38]. PAD is strongly associated with similar risk factors for other cardiovascular diseases. 70% of PAD are associated with old age (> 60 years), hypertension, smoking, diabetes, dyslipidemia, chronic renal disease, oral contraception, alcohol, HIV as demonstrated in this study (Tables 2, 4–7) [39,40]. The statistical significance of ethnicity may indicate a contribution from demography and genetics to PAD. Because of the effect of the duration of diabetes, it would have been interesting to group these patients according to the years of evolution of the disease and, also contrast with type 1 diabetes.

Table 8
The Fontaine classification of peripheral arterial disease.

Fontaine 1	Asymptomatic lower limb arterial disease
Fontaine IIa	Claudication > 200 m
Fontaine IIb	Claudication < 200 m
Fontaine III	Rest pain
Fontaine IV	Ulceration and/or gangrene

Although diabetes accelerates atherosclerosis, the distribution of vascular disease in the lower limb is thought to be different from the non-diabetic. There is more frequent involvement of vessels below the knee affecting the popliteal trifurcation and tibial arteries demonstrated as 62% in this study [41]. The distal profunda artery is also often affected which reduces the ability for collaterals to develop around the more common superficial femoral artery occlusion [42]. Despite these problems revascularization procedures are frequently successful, although a more distal anastomosis may be required [43,44]. Despite advances in non-invasive investigations, arteriography (which must include pedal arteries) remains the gold standard both for diagnosis and planning of treatment. Care is, however, needed with contrast media in patients with renal impairment.

4.1. Study limitations

The exclusion in the analysis of 22 (4.4%) participants of the 500 who had ABI greater than 1.3 would have eliminated further patients with PVD. Toe-brachial indices may have included these. The 'questionnaire' method of assessing claudication could be subjective and a detailed history and examination paying particular attention to the cardiovascular system is essential. The distribution of vascular disease cannot be determined by symptoms alone and require vascular imaging. Most patients with claudication are middle-aged or elderly and often have coexisting degenerative musculoskeletal disease such as hip or knee osteoarthritis which can mimic claudication. Some medications such as beta blockers for hypertension may exacerbate claudication. Symptoms of painful diabetic neuropathy are sometimes mistaken for intermittent claudication [45]. In addition, probably because neuropathy may mask the pain, claudication which is the hallmark of PAD is not commonly manifested in diabetics. Only a third of diabetic patients with PAD would report intermittent claudication as corroborated in this study [1–6].

5. Conclusions

Ankle brachial index (ABI) is a non-invasive vascular screening test of large vessel, peripheral arterial disease. The prevalence of peripheral arterial disease (PAD) in diabetics with ABI < 0.9 was 18% and the majority (77%) were asymptomatic with mild PAD. This is consistent with the known limitations of the use of ankle brachial indices in assessing peripheral vascular disease in diabetic patients. However, ABI can still provide useful information in patients with diabetes if values are interpreted according to the clinical situation as higher values are common. Age > 60 years, hypertension (systolic BP > 140 mmHg) and presence of foot ulcer were identified as independent risk factors.

Ethical approval

The research study was registered prospectively by the University of Douala, Cameroon. The work was approved by the ethical committee of the University of Douala, Cameroon and subjects gave informed consent to the work.

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None.

Author contribution

Elroy Patrick Weledji carried out the study design, data analysis, interpretation, writing of paper and literature search; Neville Telelen Alemnju carried out the study design, data collection, data analysis and literature search; Christophe Nouediou developed the study concept, design and data collection. All authors have read and approved the final manuscript.

Conflicts of interest

The author has no conflict of Interest.

Research registration number

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Guarantor

Professor Christophe Nouediou, National Centre for Diabetes and hypertension, Yaounde, Cameroon; Professor Marcelin Ngowe Ngowe, Dean of the faculty of Health Sciences, University of Buea.

Consent

The work was approved by the ethical committee of the University of Douala, Cameroon and subjects gave informed consent to the work.

Contributors

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Provenance and peer review

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List of abbreviations

ABI	Ankle Brachial Index
PAD	Peripheral Arterial Disease
HDLc	High Density Lipoprotein cholesterol
LDLc	Low Density Lipoprotein cholesterol
ECQ	Edinburgh's Claudication Questionnaire
MI	Myocardial Infarction

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amsu.2018.09.009.

References

[1] T. Thiruvoipati, Peripheral artery disease in patients with diabetes: epidemiology, mechanisms, and outcomes, World J. Diabetes 6 (2015) 961.
[2] National Diabetes Advisory Board: the Prevention and Treatment of Five Complications of Diabetes: a Guide for Primary Care Practitioners, Centers for disease control, Atlanta, GA, 1983 HHS publ no. 83-8392.
[3] A.T. Hirsch, M.H. Criqui, D. Treat-Jacobson, J.G. Regensteiner, M.A. Creager, J.W. Olin, et al., Peripheral arterial disease detection, awareness, and treatment in primary care, J. Am. Med. Assoc. 286 (2001) 1317–1324.
[4] L.A. Lavery, W.H. van Houtum, L.B. Harkless, In- hospital mortality and disposition of diabetic amputees in The Netherlands, Diabet. Med. 13 (1996) 192–197.
[5] R.C. Pasternak, M.H. Criqui, E.J. Benjamin, F.G. Fowkes, E.M. Isselbacher, P.A. McCullough, et al., Artherosclerotic vascular disease conference: writing group I: epidemiology, Circulation 109 (2004) 2605–2612.
[6] E. Selvin, T.P. Erlinger, Prevalence of and risk factors for peripheral arterial disease in the United States, Circulation 110 (2004) 738–743.
[7] S.T. Yao, J.T. Hobbs, W.T. Irvine, Ankle systolic pressure measurements in arterial disease affecting the lower extremities, Br. J. Surg. 56 (1969) 676–679.
[8] J.D. Baker, P.A.C. DeEtle Dix, Variability of Doppler ankle pressures with arterial occlusive disease. An evaluation of ankle index and brachial ankle pressure gradient, Surgery 89 (1980) 134–137.
[9] M.T. Vogt, J.A. Cauley, A.B. Newman, L.H. Kuller, S.B. Hulley, Decreased ankle/arm blood pressure index and mortality in elderly women, J. Am. Med. Assoc. 270 (1993) 465–469.
[10] Ubbink DTh, Tulevski II, D den Hartog, M.J.W. Koelemay, D.A. Legemate,

M.J.H.M. Jacobs, The value of non-invasive techniques for the assessment of critical limb ischaemia, Eur. J. Vasc. Endovasc. Surg. 13 (1997) 296–300.
[11] J.J.R. Bingna, J. Bahebeck, E. Sobngwi, J.C. Mbanya, Metabolic syndrome for sub-Saharan Africans diabetes with peripheral arterial disease: a control-study, BMC Res. Notes 7 (2014) 104.
[12] A.M. Jingi, J.J.N. Noubiap, A. Ellong, J.J.R. Bigna, C.E. Mvogo, Epidemiology and treatment outcomes of diabetic retinopathy in a diabetic population from Cameroon, BMC Ophthalmol. 14 (2014) 19.
[13] F.G.R. Fowkes, E. Housley, R.A. Riemersma, et al., Smoking, lipids, glucose intolerance and blood pressure as risk factors for peripheral artherosclerosis compared with ischaemic heart disease in the Edinburgh artery study, Am. J. Epidemiol. 135 (1992) 331–340.
[14] T. Yamane, Statistics; an Introductory Analysis, Harper and Row, New York, 1967.
[15] A. Menanga, B. Hamadou, Ahinaga, G. Guegang, H. Hakapoka, A. Yomba, et al., Prevalence des aeteriopathies obliterantes des membres inferieurs asymptomatiques chez des patients a risqué cardiovasculaire a L'hopital General de Yaounde, Health Sci Dis 7 (2014) 104.
[16] G.C. Lend, F.G.R. Fowkes, The Edinburgh Claudication Questionnaire: an improved version of the WHO:/Rose questionnaire for use in epidemiological surveys, J. Clin. Epidemiol. 45 (1992) 1101–1109.
[17] B.O. Oyelade, A.D. OlaOlurun, L.O. Odeigah, I.O. Amole, O.S. Adediran, The prevalence of peripheral arterial disease in diabetic subjects in south-west Nigeria? Afr. J. Prim. Health Care Fam. Med. 4 (2012) 6.
[18] Mwebaze RM, Kibirige D. Peripheral Arterial Diseases Among Adult Diabetic Patients Attending a Large Outpatient Diabetic Clinic at a National Referral Hospital in Ugasa.
[19] T. Khan, F. Farooqui, K. Niazi, Critical review of the ankle brachial index, Curr. Cardiol. Rev. 4 (2008) 101–106.
[20] T. Holland-Letz, H.G. Endres, S. Biedermann, M. Mahn, J. Kunert, S. Groh, et al., Reproducibility and reliability of the ankle-brachial index as assessed by vascular experts, family physicians and nurses, Vasc. Med. 12 (2) (2007) 105–112.
[21] X. Guo, J. Li, W. Pang, M. Zhao, Y. Luo, Y. Sun, et al., Sensitivity and specificity of anklebrachial index for detecting angiographic stenosis of peripheral arteries, Circ J 72 (2008) 605–610.
[22] L. Potier, C. Abi Khalil, K. Mohammedi, R. Roussel, Use and utility of ankle brachial index in patients with diabetes, European J Vascular & endovascular surgery 41 (1) (2011) 110–116.
[23] I. Vicente, C. Lahoz, M. Taboada, F. Laguna, F. Garcia- Iglesias, J.M. Mostaza Prieto, Ankle- brachial index in patients with DM: prevalence and risk factors, Rev. Clin. Esp. 206 (5) (2006) 225–229.
[24] B. Berglund, B. Eklund, Reproducibility of tread-mill exercise in patients with intermittent claudication, Clin. Physiol. 1 (1981) 253–256.
[25] R. Fontaine, M. Kim, R. Kieny, Surgical treatment of peripheral circulation disorders, Helv. Chir. Acta 21 (5–6) (1954) 499–533 [in German].
[26] J. Belch, A. MacCuish, I. Campbell, S. Cobbe, R. Taylor, R. Prescott, et al., The POPADAD trial: factorial randomised placebo controlled trial of aspirin and antioxidants in patients with diabetes and asymptomatic peripheral arterial disease, BMJ 337 (2008) a1840.
[27] A. Leizorovicz, F. Becker, Oral buflomedil in the prevention of cardiovascular events in patients with peripheral arterial obstructive disease, Circulation 117 (2008) 816–822.
[28] H.H. Feringa, S.E. Karagiannis, V.H. van Waning, E. Boersma, O. Schouten, J.J. Bax, et al., The effect of intensified lipid-lowering therapy on long-term prognosis in patients with peripheral arterial disease, J. Vasc. Surg. 45 (2007) 936–943.
[29] E.G. Vermeulen, C.D. Stehouwer, J.W. Twisk, M. van den Be, S.C. de Jong, A.J. Mackaay, et al., Effect of homocysteine-lowering treatment with folic acid plus vitamin B6 on progression of subclinical atherosclerosis, Lancet 355 (2000) 517–522.
[30] CAPRIE Steering Committee, A randomised, blinded, trial of clopidogrel versus aspirin in patients at risk of ischaemic events (CAPRIE), Lancet 348 (1996) 1329–1339.
[31] A.M. O'Hare, R. Katz, M.G. Shlipak, M. Cushman, A.B. Newman, Mortality and cardiovascular risk across the ankle-arm index spectrum, Circulation 113 (2006) 388–393.
[32] F.G. Fowkes, G.D. Murray, I. Butcher, C.L. Heald, R.J. Lee, L.E. Chambless, et al., Ankle brachial index combined with Framingham risk score to predict cardiovascular events and mortality, J. Am. Med. Assoc. 300 (2008) 197–208.
[33] European working group on critical leg ischaemia. Second European consensus document on chronic critical leg ischaemia, Eur. J. Vasc. Surg. 6 (A) (1992).
[34] F.C.T. Smith, C.P. Shearman, M.H. Simons, B.R. Gwynn, Falsely elevated ankle pressures in severe leg ischaemia: the pole-test – an alternative approach, Eur. J. Vasc. Surg. 13 (1994) 296–300.
[35] M.D. Flynn, M.E. Edmonds, J.E. Tooke, P.J. Watkins, Direct measurement of capillary blood flow in the diabetic neuropathic foot, Diabetologia 31 (1988) 652–656.
[36] A.I. Adler, R.J. Stevens, A. Neil, I.M. Stratton, A.J. Boulton, R.R. Holman, UKPDS 59: hyperglycemia and other potentially modifiable risk factors for peripheral vascular disease in type 2 diabetes, Diabetes Care 25 (2002) 894–899.
[37] R.E. Maser, S.K. Wolfson Jr., D. Ellis, E.A. Stein, A.L. Drash, D.J. Becker, et al., Cardiovascular disease and arterial calcification in insulin-dependent diabetes mellitus, Arterioscler. Thromb. 11 (1991) 958–996.
[38] S.G. de Vinuesa, M. Ortega, P. Martinez, M. Goicoechea, F.G. Campdera, J. Luno, Subclinical peripheral arterial disease in patients with chronic kidney disease: prevalence and related risk factors, Kidney Int. Suppl. (2005) S44–S47.
[39] M.H. Criqui, Peripheral arterial disease–epidemiological aspects, Vasc. Med. 6 (2001) 3–7.
[40] E.M. Willigendael, J.A.W. Teijnik, M.-L. Bartelink, B.W. Kuiken, J. Boiten, F.L. Moll, et al., Influence of smoking on incidence and prevalence of peripheral arterial disease, J. Vasc. Surg. 40 (2004) 1158–1165.
[41] D.E. Strandness, R.E. Priest, R.E. Gibbons, M.D. Seattle, Combined clinical and pathological study of diabetic and non- diabetic peripheral artery disease, Diabetes 13 (1961) 366–372.
[42] T.A. King, R.G. DePalma, R.S. Rhodes, Diabetes mellitus and atherosclerotic involvement of the profunda femoris artery, Surg. Gynecol. Obstet. 159 (1984) 553–556.
[43] F.F. Bartlett, G.W. Gibbons, F.C. Wheelock Jr., Aortic reconstruction for occlusive disease. Comparable results in diabetics, Arch. Surg. 121 (1986) 1150–1153.
[44] E.P. Weledji, P. Fokam, Treatment of the diabetic foot: to amputate or not? BMC Surg. 14 (2014) 83.
[45] M.J. Jacobs, D.T. Ubbink, P.J. Kitslaar, J.H. Tordoir, D.W. Slaff, R.S. Reneman, Assessment of the microcirculation provides additional information in critical limb ischaemia, Eur. J. Vasc. Surg. 6 (1992) 135–141.