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Research Article / Araştırma Makalesi

The significance of ankle-brachial index in determining peripheral artery disease in patients with type 2 diabetes mellitus over 40 years of age and the relationship of peripheral artery disease with chronic complications of diabetes

Kırk yaş üzeri tip 2 diabetes mellituslu hastalarda ayak bileği kol indeksinin periferik arter hastalığını saptamadaki değeri ve periferik arter hastalığının diyabetin kronik komplikasyonları ile ilişkisi

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ABSTRACT

Introduction: Peripheral artery disease (PAD) acts as an important predictor of mortality and morbidity in cerebrovascular and cardiovascular diseases. The incidence of PAD was reported to be 2 to 4 times higher in diabetic patients compared with non-diabetic patients. Ankle-brachial index (ABI) is an easily applicable method for the diagnosis of PAD. The aim of this study is to determine the prevalence of PAD by using ABI in patients with Type 2 diabetes mellitus (DM) over 40 years of age, compare the results with lower extremity arterial Doppler ultrasonography (USG) and to reveal the relationship between chronic complications of DM and PAD.

Material and Method: The study included 111 DM patients over 40 years of age. ABI; was calculated by dividing the higher systolic blood pressures (SBP) taken from both ankle levels to the higher SBPs measured in both arms and defined as "ABI-1". ABI-2 was calculated by dividing the lower SBPs taken from both ankle levels to the higher SBPs measured from both arms. ABI values calculated by both methods were divided into 3 groups according to cut off values. ABI values of 0.9 and less in Group 1, between 0.9 and 1.30 in Group 2, between 0.9 and 1.40 in Group 3 were interpreted in favor of PAD.

Results: The prevalence of PAD was 19.8%. The most specific group for detecting PAD was ABI-2G1, and the most sensitive groups were ABI-1G2 and ABI-2G2. A significant relationship was found between PAD and clopidogrel use, decreased vibration sensation, age, duration of DM, insulin resistance, glomerular filtration rate, albuminuria, homocysteine, and uric acid levels.

Conclusion: ABI is a sensitive method for detecting PAD. The superior side of our study compared to the other studies is that the ABI is calculated by 2 methods and ABI values are divided into 3 groups according to cut off values (≤0.9; ≤0.9- >1.30; ≤0.9->1.40).

Keywords: Peripheral artery disease, ankle-brachial index, diabetes mellitus

ÖZ

Giriş: Periferik arter hastalığı (PAH); serebrovasküler ve kardiyovasküler hastalıklarda mortalite ve morbiditenin önemli bir prediktörüdür. Diyabetik ve diyabetik olmayan hastalar karşılaştırıldığında diyabetik hastalarda PAH insidansının 2 ila 4 kat daha fazla olduğu bildirilmiştir. Ayak bileği-kol indeksi (ABI), PAH tanısında kullanılan kolay uygulanabilir bir yöntemdir. Çalışmamızda merkezimizde takip edilen 40 yaş üzeri Tip 2 diabetes mellitus (DM) hastalarında ABI ile PAH prevalansını saptamak, alt ekstremite arteriyel doppler ultrasonografi (USG) bulgularıyla kıyaslamak ve tip 2 DM'nin kronik komplikasyonları ile PAH arasındaki ilişkileri ortaya koymak amaçlanmıştır.

Gereç ve Yöntem: Çalışmaya 40 yaş üzeri 111 tip 2 DM hastası alındı. ABI; her iki ayak bileği seviyesinden alınan sistolik kan basınçlarından (SKB) daha büyük olanının, her 2 koldan ölçülen SKB'larından daha büyük olanına bölünmesiyle hesaplandı ve "ABI-1" olarak tanımlandı. Her iki ayak bileği seviyesinden alınan SKB'larından daha DÜŞÜK olanının, her iki koldan ölçülen SKB'larından daha büyük olanına bölünmesi ile de ABI-2 hesaplandı. Daha sonra her iki yöntemle de hesaplanan ABI değerleri, aralık değerlerine göre üç gruba ayrıldı. Grup 1'de 0,9 ve altı ABI değerleri, Grup 2'de 0,9 ve 1,30 arası dışındaki, Grup 3'te 0,9 ve 1,40 arası dışındaki değerler PAH lehine yorumlandı.

Bulgular: Çalışmamızdaki 40 yaş üzeri diyabetik hastalarda PAH prevalansı %19,8 olarak bulundu. PAH'ı saptamada en spesifik ABI-2G1 grubu, en sensitif ise ABI-1G2 ve ABI-2G2 grupları oldu. PAH ile klopidogrel kullanımı, azalmış vibrasyon hissi, yaş, DM süresi, insülin direnci, glomerüler filtrasyon hızı, albüminüri, homosistein ve ürik asit düzeyleri arasında anlamlı bir ilişki bulundu.

Sonuç: ABI, DM hastalarında PAH tanısı için sensitif bir yöntemdir. Çalışmamızın diğer çalışmalara göre üstün tarafı ABI'nın her iki yöntemle de hesaplanması ve ABI değerlerinin kesim noktalarına göre üçer gruba (≤0,9 ; ≤0,9 - >1,30 ; ≤0,9 - >1,40) ayrılmasıdır. Diyabetik hastalarda PAH tanısını koymak için ABI'nın özellikle ikinci hesaplama yöntemiyle (ABI-2) değerlendirilmesi, gelecekte oluşması beklenen komplikasyonların önüne geçilmesi açısından önem taşır.

Anahtar Kelimeler: Periferik arter hastalığı, ayak bileği-kol indeksi, diabetes mellitus

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INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disease that requires constant medical care in which the organism can not make sufficient use of carbohydrates, fats, and proteins due to insulin deficiency or insulin-effect defects (1). Macrovascular complications of DM include cerebrovascular disease (CVD), coronary artery disease (CAD) and peripheral artery disease (PAD). Cardiovascular disease is the primary cause of death in 55% of patients with Type 2 DM (2). PAD is an important sign of atherosclerosis and acts as an important predictor of mortality and morbidity in CVD and CAD (3).

Arteriography is the gold standard method in the diagnosis of PAD and shows the localization, severity, and extent of the disease (4). Because it is an invasive procedure, the use of arteriography is limited. Therefore, many non-invasive tests have been developed for the diagnosis of PAD. The ankle-brachial index (ABI) is the simplest and cheapest of these tests (5). ABI is the ratio of systolic blood pressure (SBP) measured at ankle level to brachial artery SBP. According to the American Diabetes Association (ADA), ABI measurement should be performed in all diabetic patients over the age of 50 (6).

The aim of this study was to determine the prevalence of PAD by ABI in Type 2 DM patients over 40 years of age and to reveal the relationship between chronic complications of type 2 DM and PAD.

MATERIAL AND METHOD

This study was conducted prospectively between December 2010 and November 2013 in endocrinology, metabolism and nutrition department of our center. 111 patients over 40 years of age diagnosed with type 2 DM according to ADA criteria were included in the study.

Ethical Declaration

The study was approved by the Ethics Committee of Eskişehir Osmangazi University (Year: 29.11.2013, Number/Decision No: 80558721/40).

ABI was measured by Hadeco Bidop ES-100V3 Doppler device by the same physician in all patients. SBPs were measured from both brachial arteries, tibialis posterior and dorsalis pedis arteries while the patients were in the supine position. ABI was calculated by dividing the higher SBPs taken from both ankle levels by the higher SBPs measured from both arms and defined as "ABI-1". ABI-2 was calculated by dividing the lower of the SBPs taken from both ankle levels by the higher SBPs measured from both arms. After calculating both right and left ABI values of each patient, the lower ABI value was taken as the patient's overall ABI value. Then, ABI values calculated by both methods were divided into three groups according to their cut off values (**Table 1**).

Table 1. Groups formed according to ABI, lower extremity Doppler ultrasound and cut off values used for the diagnosis of PAD in patients

	Measurement method for the diagnosis of PAD	Cut off value
ABİ-1G1	**Higher** SBP measured from the ankle / **Higher** brachial artery SBP	≤0,9
ABİ-1G2	**Higher** SBP measured from the ankle / **Higher** brachial artery SBP	≤0,9 and >1,30
ABİ-1G3	**Higher** SBP measured from the ankle / **Higher** brachial artery SBP	≤0,9 and >1,40
ABİ-2G1	**Lower** SBP measured from the ankle / **Higher** brachial artery SBP	≤0,9
ABİ-2G2	**Lower** SBP measured from the ankle / **Higher** brachial artery SBP	≤0,9 and >1,30
ABİ-2G3	**Lower** SBP measured from the ankle / **Higher** brachial artery SBP	≤0,9 and >1,40
Doppler USG Group	Lower extremity doppler USG performed by a radiologist	≥%50 stenosis

ABI: Ankle Brachial Index, USG: Ultrasound
Group 1 (G1): ABI values of 0.9 or less were interpreted in favor of PAD.
Group 2 (G2): Normal between 0.9 and 1.30, other values were interpreted in favor of PAD.
Group 3 (G3): Normal between 0.9 and 1.40, other values interpreted in favor of PAD.

Microalbumin excretion in 24-hour urine (mg) was calculated by the "microalbumin in 24-hour urine (mg) × 24-hour urine volume (ml)/1000" formula. Albuminuria levels of 30 mg/day and below were evaluated as normoalbuminuria, 30-300 mg/day as microalbuminuria and more than 300 mg/day as macroalbuminuria. Urine creatinine (mg/dl)×daily urine volume (ml)/serum creatinine (mg/dl)×1440 formula was used to calculate GFR (glomerular filtration rate). Chronic renal failure (CRF) was considered as creatinine elevation for at least 3 months, or as GFR being below 60 ml/min.

To determine parasympathetic autonomic neuropathy, 30/15 ratio test and heart rate response to deep breathing tests were performed. For the 30/15 ratio test, after patients were stood up with unipolar derivations of the electrocardiography (ECG), the R-R interval of their 30th heartbeat was divided by the R-R interval of their 15th heartbeat. Values of 1.04 and above were considered normal, values of 1 and below were considered abnormal, and values between the limits were considered to be borderline. Heart rate differences were found in sitting position while deep breathing 6 times in 1 minute to determine heart rate response to deep breathing. The maximum and minimum values of 6 respiratory cycles were found and their mean values were calculated. The minimum mean was subtracted from the maximum mean and recorded as beats/min. Values of 15 and above were considered normal, values of 10 and below were abnormal, and values between were considered as borderline (**Table 2**). In order to detect sympathetic autonomic neuropathy, the presence of postural hypotension was investigated in each patient. SBP changes of 30 mmHg or more when standing up were defined as postural hypo-

Table 2. Normal, borderline and abnormal values in 30/15 ratio, heart rate response to deep breathing tests

Cardiac Autonomic Neuropathy Tests	Normal	Borderline	Abnormal
30/15 ratio test	≥1.04	1.01-1.03	≤1
Heart rate response to deep breathing test	≥15	11-14	≤10

tension.For peripheral neuropathy, patients were evaluated by vibration tests on physical examination. 15 seconds or more was considered normal and less than 15 seconds was considered abnormal.

Electroneuromyography (EMG) was performed in all patients. According to EMG results, it was recorded whether the patients had sensory, motor or sensorimotor neuropathy. Insulin resistance (HOMA-IR) was calculated using the Homeostasis Model Assessment method by using the formula [(Fasting plasma glucose (mmol / L) X Fasting plasma insulin (microU / L)) / 405] (7).

HbA1c level was studied by high-performance liquid chromatography (HPLC) method. The collected data were evaluated with SPSS 15.0 program. Normality test in order to determine whether the variables were distributed normally, t-test for comparison of quantitative data showing normal distribution, Mann Whitney U test for cases that could not show normal distribution, and Chi-Square test for comparison of qualitative data were employed. A p-value of ≤0.05 was considered significant.

RESULTS

Of the 111 patients included in the study, 72 were female and 39 were male. Coexisting with DM, 87 patients had hypertension (HT), 27 had CAD, 8 had CVD, 57 had hyperlipidemia, 3 had CRF and 24 had hypothyroidism.

Table 3. Specificity and sensitivity of the groups in the diagnosis of PAD

Groups	Sensitivity	Specifity
ABI-1G1	96	81.4
ABI-1G2	100**	76
ABI-1G3	96	79.1
ABI-2G1	96	82.6**
ABI-2G2	100**	77.9
ABI-3G3	96	80.2

The prevalence of PAD was 19.8% in diabetic patients older than 40 years based on bilateral lower extremity arterial Doppler USG. Based on Doppler USG results; the sensitivity of dorsalis pedis artery palpation in detecting PAD was 100%, specificity was 82%, and kappa value was 0.644. The most specific group for detecting PAD was ABI-2G1 and the most sensitive groups were ABI-1G2 and ABI-2G2 (**Table 3**).

Relationship between PAD and age, DM duration, HOMA-IR, GFR, body mass index (BMI), albuminuria, homocysteine, phosphorus, high-density lipid (HDL), low-density lipid (LDL), triglyceride, HbA1c and uric acid levels in diabetic patients were analyzed in each group (**Table 4**).

The relationship between PAD and gender, concomitant diseases (HT, CAD, CVD, hyperlipidemia, CRF, hypothyroidism) and drugs used (metformin, sulfonylurea, acarbose, glinide, pioglitazone, dipeptidyl peptidase 4 inhibitors, basal-bolus insulin, angiotensin-converting enzyme inhibitor, calcium channel blocker, diuretic, beta-blocker, angiotensin receptor blockers, alpha antagonist, statin, fenofibrate, acetylsalicylic acid, clopidogrel, pregabalin, alpha-lipoic acid, gabapentin) in each groups were shown in **Table 5**.

Table 4. Factors related to PAD

	doppler	ABI1G1	ABI1G2	ABI1G3	ABI2G1	ABI2G2	ABI2G3
Age (years)	**0,001***	**0,009***	**0,010*****	**0,006*****	**0,007*****	**0,008*****	**0,005*****
DM duration (years)	**0,026***	0,200	0,104	0,136	0,172	0,061	0,116
BMI (kg/m2)	0,052	0,099	**0,014*****	0,072	0,097	**0,011*****	0,072
GFR (ml/min)	**0,046***	0,610	0,933	0,521	0,704	0,872	0,425
Albuminuria(mg/day)	**0,046***	0,883	0,931	0,711	0,718	0,904	0,871
Homocystein (umol/L)	**p<0,001***	**0,002***	**0,009*****	**0,005*****	**0,001*****	**0,009*****	**0,005*****
Phosphorus (mg/dL)	0,113	0,243	0,065	0,131	0,167	0,081	0,160
HDL (mg/dL)	0,865	0,740	0,931	0,733	0,908	0,898	0,901
LDL (mg/dL)	0,461	0,543	0,313	0,496	0,464	0,202	0,901
TG (mg/dL)	0,474	0,893	0,785	0,872	0,872	0,765	0,852
HbA1c (%)	0,091	0,749	0,954	0,607	0,408	0,816	0,417
Uric acid (mg/dL)	**p<0,001***	**<0,001***	0,397	0,240	**<0,001*****	**<0,001*****	0,216
HOMA-IR	**p<0,001***	**<0,001***	**<0,001*****	**<0,001***	**<0,001*****	**<0,001*****	**<0,001*****

BMI: body mass index, GFR: glomerular filtration rate, HDL: high density lipid, LDL; low density lipid, TG: triglyceride, HOMA-IR: insulin resistance calculated by HOMA method

Table 5. The relationship of PAD with gender, concomitant diseases and drugs used in each groups.

	Doppler USG	ABI1 G1	ABI1 G2	ABI1 G3	ABI2 G1	ABI2 G2	ABI2 G3
Gender	0,077	0,154	0,276	0,261	0,114	0,217	0,202
HT	0,109	0,302	0,295	0,220	0,351	0,342	0,259
CAD	0,019	0,082	0,250	0,134	0,063	0,206	0,106
CVD	0,014	0,134	0,266	0,152	0,126	0,261	0,143
HPL	0,226	0,242	0,355	0,251	0,167	0,259	0,175
CRF	0,539	p>0,05	p>0,05	>0,05	p>0,05	p>0,05	p>0,05
Hypothyroidim	p>0,05	0,582	0,564	0,452	0,652	0,633	0,514
Hepatosteatosis	0,352	0,502	0,557	0,842	1,00	0,550	0,690
MEDICATION							
Metformin	0,180	0,532	0,572	0,282	0,691	0,733	0,394
Sulfonylurea	0,691	0,491	0,523	0,499	0,317	0,514	0,494
Acarbose	0,986	0,669	0,910	0,833	0,755	p>0,05	0,924
Nateglinide	0,654	0,701	p>0,05	>0,05	0,695	p>0,05	0,708
DPPA4 inh	0,741	p>0,05	0,742	0,920	p>0,05	0,800	0,981
Basal insulin	0,851	0,962	0,897	0,914	p>0,05	0,794	0,809
Bolus insulin	0,513	0,579	0,436	0,571	0,455	0,333	0,449
ACEI	0,452	0,415	0,484	0,298	0,639	0,718	0,484
Calcium channel blockers	0,816	p>0,05	p>0,05	>0,05	p>0,05	p>0,05	p>0,05
Diuretic	0,246	0,519	0,431	0,432	0,432	0,355	0,355
Beta blocker	0,551	0,910	0,653	0,681	p>0,05	0,762	0,793
ARB	0,202	0,558	0,405	0,440	0,476	0,339	0,369
Alpha antagonist	0,654	p>0,05	p>0,05	>0,05	p>0,05	p>0,05	0,708
Statin	0,985	0,578	0,557	0,293	0,475	0,459	0,226
Fenofibrate	p>0,05	0,484	0,736	0,479	0,490	p>0,05	0,481
ASA	0,733	0,853	p>0,05	0,761	0,740	0,987	0,652
Clopidogrel	**0,002**	**0,025***	0,060	0,051	**0,022****	0,056	**0,049****
Pregabalin	p>0,05	0,480	0,866	0,626	0,414	0,784	0,551
Alfalipoic acid	0,539	p>0,05	p>0,05	>0,05	p>0,05	p>0,05	p>0,05
Gabapentin	p>0,05	0,418	0,699	0,250	0,418	0,701	0,257

HT: Hypertension; CAD: Coronary Artery Disease, CVD: Cerebrovascular Disease, HPL: Hyperlipidemia; CRF: Chronic Renal Failure; DPPA4 inh: dipeptidyl peptidase 4 inhibitors, ACEI: Angiotensin converting enzyme inhibitor, ARB: Angiotensin receptor blockers, ASA: acetylsalicylic acid

The relationship between PAD and neuropathy tests (orthostatic hypotension, decreased vibration sensation, neuropathy detected in EMG, 30/15 ratio or parasympathetic autonomic neuropathy determined by heart rate response to deep breathing, retinopathy diabetic retinopathy, hypertensive retinopathy, and nephropathy in all groups was given in **Table 6**.

DISCUSSION

When diabetic and non-diabetic patients were compared, the incidence of PAD was reported to be 2 to 4 times higher in diabetic patients (8). In China, the prevalence of PAD was 24.1% in type 2 DM patients over 60 years of age (9). In our study, the prevalence of PAD was found 19.8% in diabetic patients over 40 years of age by lower extremity peripheral Doppler USG.

In various studies, it was shown that ABI-2 method was more sensitive but less specific and less positive predictive than ABI-1 method (10). In our study, the most specific group in detecting PAD was ABI2G1 group and the most sensitive groups were ABI1-G2 and ABI2-G2 groups.

In many previous studies, a significant relationship was found between the prevalence of low ABI and age (11,12). Similarly, in our study, a significant relationship was found between PAD and age in all groups. In a study, it was found that PAD was more common in males than in females independently of age (13). Similarly, although many studies found a significant relationship between ABI prevalence and gender, Bozkurt et al. (14) found no significant dif-

Table 6. The relationship of PAD with neuropathy tests, retinopathy and nephropathy in all groups

	Doppler USG	ABI1 G1	ABI1 G2	ABI1 G3	ABI2 G1	ABI2 G2	ABI2 G3
NEUROPATHY TESTS							
Vibration test	**<0,001**	**0,028***	**0,003***	**0,008***	**0,020***	**0,002***	**0,011***
Orthostatic hypotension	0,137	p>0,05	p>0,05	>0,05	p>0,05	p>0,05	p>0,05
EMG	0,806	0,737	0,524	0,705	0,607	0,417	0,579
30/15 ratio	0,849	>0,05	0,985	0,876	0,766	0,112	0,608
Heart rate response to deep breathing	>0,05	>0,05	0,645	>0,05	p>0,05	p>0,05	p>0,05
RETINOPATHY							
Diabetic	**0,049***	0,420	0,313	0,418	0,315	0,230	0,315
hypertensive	0,768	0,842	0,387	0,639	0,626	0,251	0,450
NEPHROPATHY							
GFR	0,083	0,610	0,933	0,521	0,704	0,872	0,425
albuminuria	**0,046***	0,883	0,931	0,711	0,718	0,904	0,871

GFR: Glomerular Filtration Rate

ference between females and males in terms of ABI prevalence. In our study, no significant relationship was found between PAD and gender, similar to the study conducted by Bozkurt et al.

In a study by Monteiro et al. (15), a significant relationship was found between low ABI and the number of drugs used. In our study, there was a significant relationship between PAD and clopidogrel use in ABI-1G1, ABI-2G1, ABI-2G3, and Doppler USG groups. However, there was no significant relationship between clopidogrel use and PAD in other groups.

In a study by Escobedo et al. (16), a strong relationship was found between HbA1c levels and the risk of PAD in patients with DM. In a study conducted in China, no significant relationship was found between PAD and HbA1c levels (17). In our study, similar to the study in China, no significant relationship was found between PAD and HbA1c levels.

Monteiro et al. (15), found no significant difference between patients with and without PAD regarding GFR. In our study, a significant relationship was found between PAD and GFR in the Doppler USG group (p: 0.046). As GFR decreases, the rate of PAD increases significantly in diabetic patients. Escobedo et al. (16), showed a strong relationship between albuminuria and PAD in patients with DM. In our study, a significant relationship was found between PAD and albuminuria in the Doppler USG group (p: 0.046).

In a study conducted in United Kingdom with 3834 type 2 DM patients, a significant relationship was found between decreased sensation of vibration and PAD (18). Similarly, in our study, a significant correlation was found between decreased sensation of vibration and PAD (p <0.001).

In the studies of Fowkes et al. (11) and Langlois et al. (19), a significant relationship was found between high uric acid levels and low ABI. In our study, a significant relationship was found between PAD and uric acid levels in ABI-1G1, ABI-2G1, ABI-2G2 and Doppler USG groups (p <0.001 in all four groups).

Escobedo et al (16), showed a strong relationship between the duration of DM and PAD. In our study, a significant relationship was found between PAD and duration of DM in the Doppler USG group (p: 0.026). As duration of DM increases, the rate of PAD increases significantly. Escobedo et al. (16), revealed a significant relationship between low ABI values and obesity in men, but not in women. In our study, in ABI-1G2 and ABI-2G2 groups, a significant relationship was found between PAD and BMI (p:0.014 and p:0.011, respectively).

Uzun et al. (20), reported no relationship between the presence of HT and PAD. Similarly, there was no significant relationship between HT and PAD in our study. In a previous study, the prevalence of PAD was 16% in type 2 diabetic patients with hyperhomocysteinemia, whereas the prevalence of PAD in type 2 diabetic patients with normal homocysteine levels was only 3% (21).

In our study, a significant relationship was found between PAD and homocysteine levels in all groups. As the homocysteine level of diabetic patients' increases, the rate of PAD increases significantly. Balletshofer et al. (22), found that people with high insulin resistance had significantly more endothelial dysfunction. In our study, a significant relationship was found between PAD and HOMA-IR in all groups. As the insulin resistance of diabetic patients increases, the rate of PAD increases significantly.

As a result, in our study, as in other studies, the diagnosis of PAD made by ABI method was found to be highly concordant based on Doppler USG results. The superior side of our study compared to the other studies is that the ABI is calculated by 2 methods and the calculated ABI values

are divided into three groups according to cut off values (≤0.9; ≤0.9->1.30; ≤0.9->1.40). In order to make a definite diagnosis of PAD in risky patients, the evaluation of ABI with the second calculation method (dividing the lower of the SBPs taken from both ankle levels by the higher SBPs measured from both arms) is important in order to prevent future complications.

DECLARATION OF INTEREST STATEMENT

The authors declare that they have no conflict of interest. No financial support was received.

REFERENCES

1. Türkiye Endokrinoloji ve Metabolizma Derneği DM ve Komplikasyonlarının Tanı, Tedavi ve İzlem Kılavuzu 2019.
2. Ronald A. Codario. Çeviri: Karşıdağ K, Sağlam H. Tip 2 Diyabet, Pre-Diyabet ve Metabolik Sendrom: Birinci Basamak Tanı ve Tedavi Rehberi- Bölüm 8. Humana Press 2005.
3. Hiatt WR. Medical treatment of peripheral arterial disease and claudication. N Engl J Med 2001; 344: 1608-21.
4. Oser RF, Picus D, Hicks ME, et al. Accuracy of DSA in the evaluation of patency of infrapopliteal vessels. J Vasc Interv Radiol 1995; 6: n589–94.
5. Sorensen KE, Kristensen IB, Celermajer DS. Atherosclerosis in the human brachial artery. J Am Coll Cardiol 1997; 29: 318–22.
6. Fisher MR. American Diabetes Association: Peripheral Arterial Disease in People With Diabetes (Consensus Statement). Diabetes Care 2003 Dec; 26: 3333-41.
7. Matthews DR, Hosker JP, Rudenski AS, et al. Homeostasis model assessment: insulin resistance and beta-cell function from fasting plasma glucose and insulin concentrations in man. Diabetologia 1985; 28: 412–9.
8. Marso SP, Hiatt WR. Peripheral arterial disease in patients with diabetes. J Am Coll Cardiol 2006; 47: 921-9.
9. Thomas GN, Critchley JA, Tomlinson B, et al. Peripheral vascular disease in type 2 diabetic Chinese patients: associations with metabolic indices, concomitant vascular disease and genetic factors. Diabet Med 2003; 20: 988-95.
10. Schroder F, Diehm N, Kareem S, et al. A modified calculation of ankle–brachial npressure index is far more sensitive in the detection of peripheral arterial ndisease. J Vasc Surg 2006; 44: 531–6.
11. Fowkes FG, Murray GD, Butcher I, et al. Ankle brachial index combined with Framingham risk score to predict cardiovascular events and mortality: a meta-analysis. JAMA 2008; 300: 197-208.
12. Price JF, Stewart MC, Douglas AF, et al. Frequency of a low ankle brachial index in the general population by age, sex and deprivation: cross-sectional survey of 28,980 men and women. Eur J Cardiovasc Prev Rehabil 2008; 15: 370-5.
13. Yu J, Hwang J, Shin M, et al. The prevalence of peripheral arterial disease in korean patients with type 2 diabetes mellitus attending a university hospital; Diabetes Metab 2011; n35: 543-50.
14. Bozkurt A, Tasci I, Tabak O. Peripheral artery disease assessed by anklebrachial index in patients with established cardiovascular disease or at least one risk factor for atherothrombosis - CAREFUL Study: A national, multi-center, cross-sectional observational study. BMC Cardiovascular Disorders 2011; 11: 4.
15. Monteiro R, Marto R, Neves M. Risk factors related to low ankle-brachial ındex measured by traditional and modified definition in hypertensive elderly patients. Int J Hipertens 2012 June; 163: 807. doi: 10.1155 / 2012/163807. EPUB 2012 June 7.
16. Jorge Escobedo J, S. Rana, Lombardero M, et al. Association between albuminuria and duration of diabetes and myocardial dysfunction and peripheral arterial disease among patients with stable coronary artery disease in the BARI 2D Study. Mayo Clin Proc 2010 Jan; 85: 41-6.doi: 10.4065/mcp.2009.0265.
17. Wang Li, Du Fan, MAO Hong, et al. Prevalence and related risk factors of peripheral arterial disease in elderly patients with type 2 diabetes in Wuhan, Central China. Chin Med J (Engl) 2011 Dec; 124: 4264-8.
18. Adler A, Stevens R, Neil A. UKPDS 59: Hyperglycemia and other potentially modifiable risk factors for peripheral vascular disease in type 2 diabetes. Diabetes Care 2002 May; 25: 894-9.
19. M. Langlois, D. De Bacquer, D. Duprez, et al. Serum uric acid in hypertensive patients with and without peripheral narterial disease. Atherosclerosis 2003; 1: 163–8.
20. Uzun Ş, Vural H, Uzun M, et al. Koroner kalp hastalığı ciddiyetinin tahmininde kolay bir fiziksel değerlendirme bulgusu olan ayak bileği-kol indeksinin kullanılması, Gülhane Tıp Derg 2005; 47: 279-81.
21. Filippella M, Lillaz E, Ciccarelli A, et al. Ankle brachial pressure index usefulness as predictor factor for coronary heart disease in diabetic patients. J Endocrinol Invest 2007; 30: 721-5.
22. Balletshofer B, Rittig K, Markus D, et al. Endothelial dysfunction ıs detectable in young normotensive first-degree relatives of subjects with type2 diabetes in association with ınsulin resistance. Circulation 2000; 101: 1780-4.