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Assessment of ankle–brachial pressure index in elderly patients as screening for lower extremity ischemia in the context of medical test method used

Ocena wskaźnika kostka–ramię u seniorów jako badanie przesiewowe w diagnostyce niedokrwienia kończyn dolnych w kontekście zastosowanych metod badania i w odniesieniu do młodszych pacjentów

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ABSTRACT

Introduction: The ankle–brachial pressure index (ABI) is the ratio of the systolic blood pressure of the dorsalis pedis or posterior tibial arteries to the upper arm.

The study attempted to identify factors which determine the ABI measurement results.

Materials and methods: The research subject was the measurement of the ankle–brachial pressure index by means of continuous Doppler (cwD) and BOSO ABI-SYSTEM 100 apparatus (ABIs) in patients suffering from chronic venous insufficiency, lower extremity ischemia and diabetes. 100 outpatients participated in the study, which was conducted in the Chronic Injury Clinic of No. 1 Ludwik Rydygier University Hospital in Bydgoszcz between 28th June 2016 and 6th April 2017.

Results: The average ABI value among all the examined patients was: right extremity – 0.999 (cwD), 0.954 (ABIs); left extremity – 0.980 (cwD), 0.945 (ABIs); with standard deviation of 32.9% (cwD) and 30.1% (ABIs) for the right extremity, and 34.2% (cwD) and 32.1% (ABIs) for the left extremity, which shows a considerable result differentiation. On average, the diabetes patients had the highest index – 1.163 (cwD) for the right extremity and 1.196 (cwD) for the left extremity – while the arteriosclerosis patients had the lowest index – 0.750 for the right extremity and 0.684 for the left extremity (cwD).

Conclusions: The ABI values measured by continuous Doppler and BOSO ABI-SYSTEM 100 apparatus did not differ in a statistically significant way mainly in the case of the patients with chronic venous insufficiency and lower extremity arteriosclerosis. However, the values differed at the lower right and left extremities. The patients' sex, age, education and clinical analysis partly determined the ABI test results. The patients aged 61–70 and the oldest patients had the lowest ABI values.

Keywords: ankle–brachial index; aging; atherosclerosis; peripheral artery disease; diabetes.

ABSTRAKT
Wstęp: Wskaźnik kostka–ramię (ABI) wyraża stosunek ciśnienia skurczowego w tętnicach zlokalizowanych na podudziach, tj. tętnicy piszczelowej tylnej bądź tętnicy grzbietowej stopy, do ciśnienia panującego w tętnicy ramiennej.
Celem niniejszej pracy było porównanie wartości ABI mierzonego za pomocą detektora dopplerowskiego fali ciągłej (DDFC) oraz urządzenia BOSO ABI-SYSTEM 100 (ABIs) u seniorów, a także próba określenia czynników determinujących wyniki badań w porównaniu z pacjentami młodszymi.
Materiały i metody: Przedmiotem przeprowadzonego badania był pomiar ABI przy użyciu DDFC oraz urządzenia ABIs wśród pacjentów z przewlekłą niewydolnością żylną, niedokrwieniem kończyn dolnych oraz cukrzycą. Badania przeprowadzono po uzyskaniu zgody Komisji Bioetycznej nr KB 523/2016 z dnia 28.06.2017 r. przy Uniwersytecie Mikołaja Kopernika w Toruniu, Collegium Medicum w Bydgoszczy w okresie 28.06.2016–6.04.2017 r. Miejscem realizacji badań była Poradnia Leczenia Ran Przewlekłych w Szpitalu Uniwersyteckim nr 1 im. Ludwika Rydygiera w Bydgoszczy.
Wyniki: Średnia wartość ABI wśród wszystkich badanych wyniosła w kończynach: prawej – 0,999 (DDFC), 0,954 (ABIs), lewej – 0,980 (DDFC) i 0,945 (ABIs); z odchyleniem standardowym 32,9% (DDFC), 30,1% (ABIs) dla kończyny prawej i 34,2% (DDFC), 32,1% (ABIs) dla kończyny lewej wartości średniej, co świadczy o dużym zróżnicowaniu wyników. Średnio najwyższy wskaźnik uzyskali pacjenci z cukrzycą (1,163 DDFC – dla kończyny prawej, 1,196 DDFC – dla kończyny lewej), a najniższy – badani z miażdżycą (0,750 – kończyna prawa, 0,684 – kończyna lewa DDFC).
Wnioski: Wyniki pomiaru ABI za pomocą DDFC oraz ABIs nie wykazują istotnych statystycznie różnic mogących wpływać na postawienie diagnozy. Płeć, wiek, wykształcenie i analiza kliniczna pacjentów częściowo określiły wyniki testu ABI. Pacjenci w wieku 61–70 lat i najstarsi mieli najniższe wartości ABI.
Słowa kluczowe: wskaźnik kostka–ramię; starzenie się; miażdżyca tętnic, choroba tętnic obwodowych; cukrzyca.

INTRODUCTION

The ankle–brachial pressure index (ABI) is the ratio of the systolic blood pressure in the dorsalis pedis or posterior tibial arteries to that in the upper arm [1]. The ABI is acknowledged to be a basic screening method for acute and chronic lower extremity ischemia. Yao from St. Mary's Hospital in London proved that the degree of arteriosclerotic change closely correlates with the index value. Unlike pulse palpation, ABI is an objective medical test, which makes it useful in terms of lower extremity pain differential [2, 3]. Also, it is advisable to calculate the ankle–brachial pressure index for any patient who may need compression therapy [1, 2, 3].

Patients suffering from arteriosclerosis have a lower systolic blood pressure in their lower extremities than in the brachial artery. There is a difference of ca. 20 mmHg between the left and right brachial artery pressures in about 3.5% of healthy people. The difference can be as high as over 20% in patients with obliterative arteriosclerosis, and this is why it is advisable to calculate the ankle–brachial pressure index in both brachial arteries [1].

Obliteration and calcination changes in the walls are rarely observed in the dorsalis pedis arteries. The toe-brachial index, the ratio of systolic blood pressures measured at the toe and the brachial artery, is an objective medical test for diabetes patients. The systolic blood pressure measured at the toe or an index value lower than 0.6 correlates with severe ischemia [4].

It is advisable to calculate the ankle–brachial pressure index in order to 1) screen patients who are over 70; 2) screen patients who suffer from lower extremity exertional pain; 3) screen patients aged 50–69 with arteriosclerosis and diabetes risk factors as well as those who smoke cigarettes; 4) confirm acute and chronic extremity ischemia diagnoses; 5) diagnose extremity ischemia when there are no symptoms. The ABI calculation should also be done 1) in the case of differential diagnosis of lower extremity pain; 2) in order to estimate the risk of cardiovascular complications over a 10 year period according to the Heart Score and Framingham risk score; 3) for aetiology differentiation of lower extremity ulceration; 4) for monitoring the conservative treatment of chronic lower extremity ischemia (an increase in ABI may opt for the creation of collateral circulation); 5) before compression therapy is started; 6) in order to monitor patient health state during their compression treatment (lowering of the index value by 0.1–0.15 indicates a clinically significant decline in the blood supply of an extremity) [3, 4, 5, 6].

Physical examination is a basic competence of nurses acquired in first cycle studies and is developed during postgraduate studies. The ABI measurement is one of the specialist medical tests carried out by nurses. An authorised nurse may undertake and interpret the ABI calculation themselves, without a physician referral, after completing a specialist training course [3, 4].

MATERIALS AND METHODS

The purpose of the research study was to compare the ankle–brachial pressure index values measured in elderly patients by means of a continuous Doppler and a BOSO ABI-SYSTEM 100. The study also attempted to identify the factors which determined the ABI measurement results.

The research subject was the measurement of the ankle–brachial pressure index by means of continuous Doppler and BOSO ABI-SYSTEM 100 apparatus in patients suffering from chronic venous insufficiency, lower extremity ischemia and diabetes.

One hundred outpatients (48 women and 52 men) participated in the study, which was conducted in the Chronic Injury Clinic of No. 1 Ludwik Rydygier University Hospital in Bydgoszcz between 28th June 2016 and 6th April 2017. The Bioethical

Committee of the Bydgoszcz Collegium Medicum affiliated to the Nicolaus Copernicus University in Toruń approved the study (Resolution no. KB 523/2016 dated 28 June 2016). Each patient participating in the study had to be an adult. The patients were divided into three groups: 34 patients with chronic venous insufficiency, 33 diabetes patients, and 33 patients suffering from lower extremity arteriosclerosis. Men were in the majority in the arteriosclerosis group and the diabetes group – 19 (57.7%) and 21 (63.6%) respectively – whereas women were in the majority in the venous insufficiency group – 22 (64.7%). The average age of the patients was nearly 66. The oldest patients were those suffering from arteriosclerosis; their average age was over 71. The youngest patients were those with venous insufficiency; their average age was over 62. The most advanced age was similar in all the three groups, the oldest being a 91-year-old diabetes patient.

Before the research began, the patients were informed of its purpose and methods. Having given their written consent to the research, the patients filled in a questionnaire on their own or with the assistance of a nurse, and then their ABI was measured by means of a continuous Doppler and a BOSO ABI-SYSTEM 100 apparatus.

The index values were given in millimetres of mercury (mmHg). The ratio was calculated as the quotient of the systolic blood pressure measured at the lower extremities (the average pressure in the tibial arteries) to the systolic blood pressure in the upper arm. The index values were recorded in the patients' ABI medical history sheets. For the assessment of the results, the following interpretation of the ABI was used: 1.30–0.90 = normal lower extremity blood supply; 0.89–0.60 = mild peripheral artery disease; 0.59–0.40 = moderate peripheral artery disease; <0.39 severe peripheral artery disease; >1.3 = disproportionate values/lack of susceptibility of arteries to compression/additional medical test on extremity blood supply is needed [1, 4].

The descriptive analysis of the research shows the numbers and percentages of the answers to the respective questions. Also, arithmetic means and standard deviations were used. The correlation of two variables was calculated by means of Spearman's rank correlation coefficient, whereas the nonparametric Mann–Whitney U test was used in order to assess differences in one of the features between the two groups. Also, the nonparametric Wilcoxon signed-rank test was used to assess the differences in one feature for one of the groups in two different measurements.

The $p \leq 0.05$ level was assumed to be statistically significant. The Statistica 10.0 software and Microsoft Excel were used to make all the calculations and figures.

RESULTS

The ABI results produced by continuous Doppler (cwD) and the BOSO ABI-SYSTEM 100 (ABIs) were analysed. The average ABI values among all the examined patients were: right extremity – 0.999 (cwD), 0.954 (ABIs); left extremity – 0.980 (cwD), 0.945 (ABIs); with standard deviations of 32.9% (cwD) and 30.1% (ABIs) for the right extremity, and 34.2% (cwD) and 32.1% (ABIs) for the left extremity, which shows a considerable result difference. On average, the diabetes patients had the highest index – 1.163 (cwD) for the right extremity and 1.196 (cwD) for the left extremity – while the arteriosclerosis patients had the lowest index – 0.750 for the right extremity and 0.684 for the left extremity (cwD). In the case of the medical test carried out by means of the BOSO ABI-SYSTEM 100 apparatus, the group of venous insufficiency patients had the highest average index for the right extremity – 1.039, and the arteriosclerosis patients had the lowest index – 0.722. As for the left extremity, the diabetes patients had the highest index – 1.085, and the arteriosclerosis patients had the lowest index – 0.62.

The minimum index values were different, the lowest ones being 0.211 (cwD) and 0.373 (ABIs) for the right extremity, and 0.333 (cwD) and 0.380 (ABIs) for the left extremity (the arteriosclerosis group). The maximum index values were also different, the highest ones being 2.167 (cwD) for both the right and the left extremities, and 1.568 (ABIs) for the right extremity and 1.705 (ABIs) for the left extremity.

Half of the examined patients had normal lower extremity blood supply – 51.0% (cwD) and 61.2% (ABIs) at the right extremity, and 51.5% (cwD) and 59.8% (ABIs) at the left extremity – as well as mild peripheral artery disease – 20.4% (cwD) and 17.3% (ABIs) at the right extremity; 22.7% (cwD) and 15.5% (ABIs) at the left extremity. Moderate peripheral artery disease affected the lowest number of the examined patients – 3.1% (ABIs). Severe peripheral artery disease – 4.0% (cwD). Among the patients suffering from arteriosclerosis, those with mild peripheral artery disease were in the majority – 34.4% (cwD) and 40.6% (ABIs) at the right extremity, and 43.8% (cwD) and 37.5% (ABIs) at the left extremity – and those with severe peripheral artery disease – 12.5% (cwD) for both the right and the left extremities; 18.8% (ABIs) at the left extremity – and with moderate peripheral artery disease – 3.1% (ABIs) at the right extremity – were in the minority. Among the patients suffering from venous insufficiency, the majority had normal peripheral artery blood supply – 85.3% (cwD) for both extremities; 85.3% (ABIs) at the right extremity – and the minority had a disproportionate index value – 5.9% (cwD) and 5.9% (ABIs) for both extremities. Among the diabetes patients, the majority had either a disproportionate index value or normal lower extremity blood supply – 37.5% (cwD) and 68.8% (ABIs) at the right extremity; at the left extremity: 45.2% with normal blood supply and 35.5% with a disproportionate index value. The minority of the diabetes patients suffered from moderate peripheral artery disease (6.3% cwD) at the right extremity; 3.2% (cwD) at the left extremity) or mild peripheral artery disease (3.1% ABIs). Due to the significance level ($p < 0.05$), statistically significant differences concerning the assessment of the ABI for both extremities were noted among the examined groups of patients. This confirmed the hypothesis about the ABI values measured by continuous Doppler and BOSO ABI-SYSTEM 100 being different in the right and left extremities.

The male patients had higher ABI values at both extremities than the female patients in the venous insufficiency and diabetes groups, whereas in the arteriosclerosis group it was the female patients that had higher ABI values. The male patients had lower ABI values while examined by means of the BOSO ABI-SYSTEM 100. As for the right extremity, the male patients with arteriosclerosis and venous insufficiency and the female patients with diabetes had higher ABI values. As for the left extremity, female patients with arteriosclerosis and diabetes had higher ABI values.

In the arteriosclerosis group, the patients aged up to 60 had the highest ABI values measured by both continuous Doppler and the BOSO ABI-SYSTEM 100 (at both extremities). Those aged 61–70 had the lowest ABI values in the right extremity, and those aged over 70 had the lowest ABI values in the left extremity. In the venous insufficiency group, the patients aged 61–70 had the highest ABI value measured at both extremities by means of continuous Doppler, while those aged up to 60 had the lowest ABI value. Examined by means of the BOSO ABI-SYSTEM 100 apparatus, the patients aged up to 60 had the highest ABI value, and those aged over 70 had the lowest ABI value. In the diabetes group, the patients aged 61–70 had the highest ABI value at both extremities regardless of the medical test method; those aged over 70 had the lowest ABI value. The patient age had no statistically significant correlation with the ABI results, in neither the whole group nor the subgroups, i.e. lower extremity arteriosclerosis, chronic venous insufficiency, and diabetes patients ($p > 0.05$) – Tables 1 and 2.

Neither the patient education nor the place of residence correlated with the ABI results in a statistically significant way ($p > 0.05$). The patient education played an important role only in the case of automatic measurement in the diabetes group; the more educated the patients were, the higher their ABI values were.

DISCUSSION

The ankle–brachial pressure index continues to be the golden standard and one of the basic types of screening for lower extremity ischemia. It is also used for the assessment of risk for other vascular system disorders [3, 6, 7, 8].

The results presented in this research study confirm that the ABI values measured by means of continuous Doppler and the BOSO ABI-SYSTEM 100 apparatus differed significantly in the lower right and left extremities. According to Beckman et al., the average differences in the ABI results obtained in 2004 (Cardiovascular Division, Brigham and Women's Hospital, Harvard Medical School, Boston, Mass.) ranged 0.01–0.06 [9]. This was also confirmed by the examination of 193 diabetes

TABLE 1. Age groups and ankle–brachial pressure index results correlations

Group	Extremity	No.	R		t (N-2)		p	
			cwD	ABIs	cwD	ABIs	cwD	ABIs
Total	right	98	−0.175	−0.175	−1.737	−1.737	0.086	0.086
	left	97	−0.180	−0.180	−1.786	−1.786	0.077	0.077
Arteriosclerosis	right	32	−0.115	−0.115	−0.633	−0.633	0.531	0.531
	left	32	−0.222	−0.222	−1.246	−1.246	0.222	0.222
Venous insufficiency	right	34	−0.091	−0.091	−0.520	−0.520	0.607	0.607
	left	34	−0.002	−0.002	−0.014	−0.014	0.989	0.989
Diabetes	right	32	−0.196	−0.196	−1.092	−1.092	0.283	0.283
	left	31	−0.130	−0.130	−0.705	−0.705	0.486	0.486

R – correlation coefficient; t(N-2) – Student t-test

TABLE 2. Average ankle–brachial pressure index results in the age groups

Extremity		Right				Left			
group	age	average		SD		average		SD	
		cwD	ABIs	cwD	ABIs	cwD	ABIs	cwD	ABIs
Arteriosclerosis	up to 60	1.006	1.006	0.239	0.239	0.794	0.794	0.206	0.196
	61–70	0.691	0.691	0.200	0.200	0.685	0.685	0.196	0.251
	over 70	0.691	0.691	0.293	0.293	0.648	0.648	0.251	0.101
Venous insufficiency	up to 60	1.024	1.024	0.113	0.113	1.053	1.053	0.101	0.182
	61–70	1.157	1.157	0.233	0.233	1.097	1.097	0.182	0.053
	over 70	1.036	1.036	0.113	0.113	1.026	1.026	0.053	0.342
Diabetes	up to 60	1.156	1.156	0.252	0.252	1.233	1.233	0.342	0.380
	61–70	1.197	1.197	0.394	0.394	1.220	1.220	0.380	0.439
	over 70	1.107	1.107	0.476	0.476	1.090	1.090	0.439	0.206

cwD – continous Doppler; ABIs – BOSO ABI-SYSTEM 100 apparatus

patients in Sri Lanka in 2015; their average ABI value in the right extremity was 1.07, and 1.08 at the left one [10].

The present study also confirmed that the male patients suffering from chronic venous insufficiency had higher ABI values (statistically significant) than the female patients. Similarly, the research conducted by Ramos et al. (2,903 men and 3,269 women) confirmed that male patients with lower extremity arteriosclerosis had lower ABI values [11]. Finnish scientists reported some slight differences in this subject, too [12].

Murabito et al. reported that some ABI results correlated with patient age; 20% of the patients aged 80 had low ABI (<0.9) [13]. Cacoub et al. observed that patients aged 74 and above have lower ABI values and a higher risk for peripheral artery disease [8].

The analysis of the data collected in the study allows us to state that the results of the ABI tests carried out by means of continuous Doppler and BOSO ABI-SYSTEM 100 apparatus do not show statistically significant differences which could affect the establishment of a diagnosis [9]. However, diabetes patients have higher ABI values when 'manually' tested by means of continuous Doppler, as opposed to the 'automatic' mode of BOSO ABI-SYSTEM 100 apparatus. By contrast, a value <0.9 in the research study by Su et al. was crucial to the assessment of the risk for coronary disease [14], and the authors of another research conducted in Copenhagen stated that this method may produce false results and aggravate the diagnostic process by categorising people with a normal ABI as those suffering from a disease [15].

As people become older, the risk for lower extremity ischemia becomes greater. Demographic data indicates that over 20% of the population of Western Europe aged over 65 have symptoms or features of ischemia, which is confirmed by the ABI tests conducted by Span et al. [12].

It may be impossible to determine the ABI in the case of some patients; its value may also be overestimated, which results in a failure to correlate it with the degree of these patients' extremity ischemia. This happens when patients suffer from diabetes and extreme renal insufficiency; their ABI values are disproportionately high then (>1.4). In such situations, according to the guidelines formulated in the Trans-Atlantic Inter--Society Consensus Document on Management of Peripheral Arterial Disease (TASC II), blood pressure should be measured at the toes (the toe-brachial index – TBI). This makes it possible to obtain proper distal systolic blood pressure values. Blood pressure measure at the toe is lower by ca. 30 mmHg than blood pressure measured at the ankle [3, 16].

The research carried out by Aso et al. concerning patients with type 2 diabetes confirmed the correlation of lower ABI and TBI (the toe-brachial index) values with the risk for lower extremity ischemia. Thus, diabetes patients should undergo TBI tests [17, 18].

The ankle–brachial index provides us with reliable information and constitutes one of the standard elements of the preliminary examination of patients who are suspected to have lower extremity ischemia. Both continuous – wave Doppler and BOSO ABI-SYSTEM 100 apparatus can be successfully used for the ABI tests as the index value differences are slight and noted mainly in the case of diabetes patients, who – according to the TASC II guidelines – should also undergo TBI tests.

CONCLUSIONS

The ABI values measured by continuous–wave Doppler and BOSO ABI-SYSTEM 100 apparatus did not differ in a statistically significant way mainly in the case of the patients with chronic venous insufficiency and lower extremity arteriosclerosis. However, the values differed at the lower extremities.

The patients' sex, age, education and clinical analysis partly determined the ABI test results. When tested by means of BOSO ABI-SYSTEM 100 apparatus, the patients aged up to 60 – especially the male patients with chronic venous insufficiency and diabetes patients – had the highest ABI values. The patients aged 61–70 and the oldest patients had the lowest ABI values.

In order to propagate ABI tests for screening and basic diagnostics of extremity vascular changes as well as to decrease the costs of such tests, conducting ABI tests should become part of nurses' basic competencies. Nurses' ability to carry out these tests should be enhanced through specialist training courses.

REFERENCES

1. Jawień A, Szewczyk MT. Kliniczne i pielęgnacyjne aspekty opieki nad chorym z owrzodzeniem żylnym. Ocena wskaźnika kostka–ramię. Poznań: Termedia Wydawnictwo Medyczne; 2008. p. 89-94.
2. Krzesiński P, Niedolaz K, Piotrowicz K, Gielerek G. Przydatność oceny wskaźnika kostka–ramię w praktyce klinicznej. Forum Med Rodz 2014;8(3):117-26.
3. Migdalski A, Jawień A. Wartość kliniczna wskaźnika kostka–ramię. Pielęg Chir Angiol 2016;1:26-33.
4. Szewczyk MT, Jawień A, Mościcka P, Cierzniakowska K, Cwajda-Bialasik J, Woda Ł. Badanie fizykalne i postępowanie pielęgniarskie w schorzeniach układu naczyniowego kończyn dolnych. Pielęg Chir Angiol 2012;2:43-51.
5. Szewczyk MT, Jawień A. Zalecenia specjalistycznej opieki pielęgniarskiej nad chorym z owrzodzeniem żylnym goleni. Ocena obwodowego ukrwienia kończyny z owrzodzeniem i pomiar wskaźnika kostka–ramię (WK/R). Pielęg Chir Angiol 2007;1:100-2.
6. Tehan PE, Barwick AL, Sebastian M, Chuter VH. Diagnostic accuracy of the postexercise ankle-brachial index for detecting peripheral artery disease in suspected claudicants with and without diabetes. Vasc Med 2018;23(2):116-25. doi: 10.1177/1358863X17751259.
7. Potier L, Abi-Khalil C, Mohammedi K, Roussel R. Use and utility of the ankle-brachial index in patients with diabetes. Eur J Vasc Endovasc Surg 2011;41(1):110-6. doi: 10.1016/j.ejvs.2010.09.020.
8. Cacoub P, Cambou JP, Kownator S, Belliard JP, Beregi JP, Branchereau A, et al. Prevalence of peripheral arterial disease in high-risk patients using the ankle-brachial index in general practice: a cross-sectional study. Int J Clin Pract 2009;63(1):63-70. doi: 10.1111/j.1742-1241.2008.01953.x.
9. Beckman AJ, Higgins OC, Herman-Gerhard M. Automated oscillometric determination of the ankle–brachial index provides accuracy necessary for office practice. Hypertension 2006;47:35-8.
10. Ranasinghe LD, Somasundaram NP, Wickramasinghe SW, Ranawake N, Jayasena KR. Reliability of the ankle-brachial pressure index measured by pulse palpation method in diagnosing peripheral arterial disease among patients with diabetes mellitus. Sri Lanka J Diabetes Endocrinol Metabolism 2015;5:65-8.
11. Ramos R, Quesada M, Solanas P, Subirana I, Sala J, Vila J, et al. Prevalence of symptomatic and asymptomatic peripheral arterial disease and the

value of the ankle-brachial index to stratify cardiovascular risk. Eur J Vasc Endovasc Surg 2009;38:305-11. doi: 10.1016/j.ejvs.2009.04.013.
12. Span M, Gersak G, Millasseau SC, Meza M, Kosir A. Detection of peripheral arterial disease with an improved automated device: comparison of a new oscillometric device and the standard Doppler method. Vasc Health Risk Manag 2016;12;305-11. doi: 10.2147/VHRM.S106534.
13. Murabito JM, Evans JC, Larson MG, Nieto K, Levy D, Wilson PW. The ankle-brachial index in the elderly and risk of stroke, coronary disease and death. Arch Intern Med 2003;163(16):1936-42. doi: 10.1001/archinte.163.16.1939.
14. Su HM, Voon WC, Lai WT, Lee KT, Chu CS, Lin TH, et al. Ankle-brachial index measured by an automated oscillometric method as a predictor of cardiovascular events in patients with coronary arterydisease. Acta Cardiol Sin 2005;21:13-8.
15. Korno M, Eldrup N, Sillesen H. Comparison on ankle-brachial index measured by an automated oscillometric apparatus with that by standard Doppler technique in vascular patients. Eur J Vasc Endovasc Surg 2009;38(5);610-5. doi: 10.1016/j.ejvs.2009.07.004.
16. Norgren L, Hiatt WR. Konsensus dotyczący postępowania w chorobach tętnic obwodowych (TASC II). Acta Angiol 2007;13 Supl. D:D1-D80.
17. Aso Y, Okumura KI, Inoue T, Matsutomo R, Yoshida N, Wakabayashi S, et al. Results of blood inflammatory markers are associated more strongly with the toe-brachial index than with the ankle-brachial index in patients with type 2 diabetes. Diabetes Care 2004;27(6):1381-6.
18. Cierzniakowska K, Szewczyk MT, Kozłowska E, Mościcka P, Górka A, Popow A, et al. Wskaźnik kostka–ramię – efektywna diagnoza chorób tętnic obwodowych. Pielęg Chir Angiol 2016;1:26-33.