SUNTEXT REVIEWS

SunText Review of Renal Sciences

Open Access
Commentary Article
Volume 3:1

The Measurement of Skin Perfusion Pressure (SPP) For Continuing Hemodialysis Patients for Years

Kakutani H[1], Kato Y[1], Bando H[1,2,3,*], Fujikawa T[1], Kato Y[1], Yamamoto M[1], Okada K[1], Narutaki M[1], Kadota T[1], Kajimoto S[1], Ishikura K[1] and Kawata T[1]

[1]*Kanaiso Hospital, Tokushima, Japan*
[2]*Tokushima University / Medical Research, Tokushima, Japan*
[3]*Japan Low Carbohydrate Diet Promotion Association, Kyoto, Japan*

[*]**Corresponding author:** Bando H, Tokushima University /Medical Research, Nakashowa 1-61, Tokushima 770-0943, Japan; E-mail: pianomed@bronze.ocn.ne.jp

Received date: 06 June 2024; **Accepted date:** 11 June 2024; **Published date:** 15 June 2024

Citation: Kakutani H, Kato Y, Bando H, Fujikawa T, Kato Y, Yamamoto M, et al. (2024). The Measurement of Skin Perfusion Pressure (SPP) For Continuing Hemodialysis Patients for Years. SunText Rev Renal Sci 3(1): 119.

Abstract

Patients with hemodialysis (HD) have frequent peripheral artery disease (PAD). The possibility of PAD has been examined by ankle-brachial index (ABI), and recently useful measurement of skin perfusion pressure (SPP) has been introduced to clinical practice. Current study included 36 HD cases with 75.8 years old, and 13.3 years of HD period in average. By categorizing by HD duration, three group of 12 case each showed median value of 4.9, 10.6, 22.7 years, respectively. The latter group tends to show lower SPP compared with other two groups by quartile analysis. All groups showed significant correlation with SPP and amplitude.

Keywords: Skin perfusion pressure (SPP); Hemodialysis (HD); Peripheral artery disease (PAD); Ankle-brachial index (ABI); Wound, Ischemia, and foot Infection (WIfI)

Introduction

Authors and co-researchers have continued various clinical practice and research for years. Among them, various treatments are conducted including type 2 diabetes (T2D), cerebral vascular accident (CVA), ischemic heart disease (IHD), peripheral artery disease (PAD), chronic kidney disease (CKD), hemodialysis (HD), and other diseases [1]. Our hospital has HD department, and lots of HD patients have been treated. They have generalized problems in vascular diseases [2,3].

Especially, HD patients have frequent PAD in lower extremities, leading to crucial condition. Most severe situation would become acute limb ischemia (ALI) that progressively worsens within 2 weeks [4]. Due to comorbid conditions including CVA, IHD, the mortality rate remains high at 15–20% [5]. Before ALI, chronic vascular problem has been observed, which was formerly called as arteriosclerosis obliterans (ASO), and recently called as lower extremity artery disease (LEAD) [6]. For the diagnosis of LEAD, popular examination is known for ankle-brachial index (ABI) [7]. Recent trends introduced Wound, Ischemia, and foot Infection (WIfI) classification, which is from the Society for Vascular Surgery WIFI [8]. It would be useful for the management of PAD cases.

Furthermore, useful measurement of skin perfusion pressure (SPP) has been recently introduced to clinical practice. SPP refers to the perfusion pressure in the microcirculation of skin tissue, and it seems to be an index for maintaining material exchange. SPP can be applied for the assessment the severity of chronic limb-threatening ischemia (CLTI) and to decision of treatment options [9]. Authors have reported several articles about CKD, HD, and related clinical matters. We have tried to evaluate the status of PAD for HD patients by using SPP examination. From our experience, general data of SPP for HD patients with some related perspectives will be described in this article.

Patients and Methods

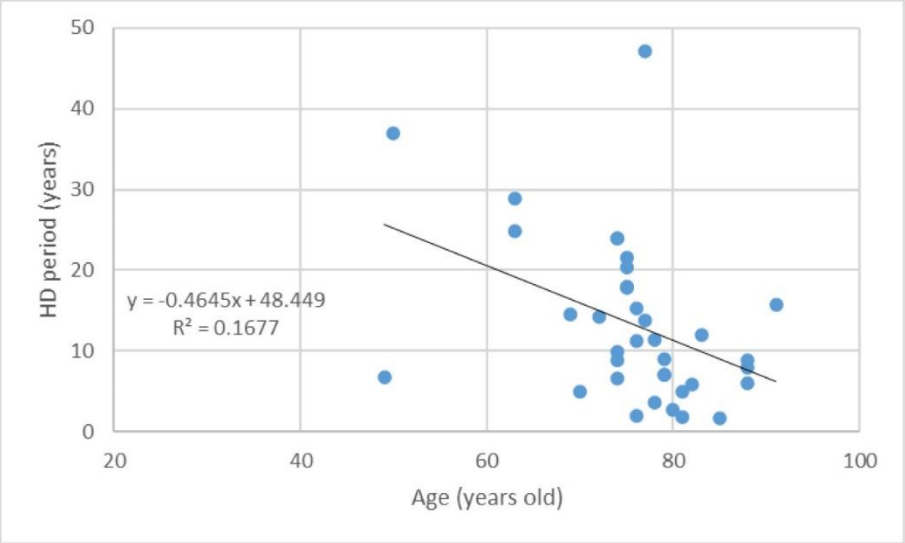
In this study, patients have received regular HD three times a week for years. We analyzed data from 41 consecutive SPP tests that have been recently performed at Kanaiso Hospital. They received SPP exams in right and left feet. Among them, 5 cases

showed blank data of either right or left foot because of probable occlusive status from their PAD situation. We have omitted 5 cases, and 36 cases were investigated for statistical examination, associated with complete data of plantar/dorsal sites of right/left sides. Among 36 applicants, male and female were 24 and 12 cases, respectively.

Table 1: *General data of the cases in current study.*

	Factor	Ave	SD	min	25%	median	75%	max	Unit
Cases	Age (yr)	75.8	8.9	49	74	76	80.25	91	(years)
	HD period	13.3	10.1	1.7	6.5	10.6	17.9	47	(years)
Data	R-plantar	60.4	21.3	20	43.3	60	76.3	124	(mmHg)
	R-dorsal	62.3	23.5	23	49.3	61	71.3	142	(mmHg)
	L-plantar	56.4	22.2	15	39.0	54	74.0	102	(mmHg)
	L-dorsal	61.8	22.1	19	48.5	61	73.8	110	(mmHg)
	R-amplit	39.4	14.9	17	29.8	37	45.8	80	(mm)
	L-amplit	36.8	16.4	7	26.8	38	47.3	69	(mm)

Figure 1*: Correlation between age and HD period.*



Methods included the measurement of SPP by the clinical apparatus of PAD4000 developed by Kaneka Medical Product, Japan, which is product No. 22500BZX00516000 [10]. It can measure 0.0-4.1% skin perfusion stream, 0-250 mmHg as SSP, 0-80 mm of maximum amplitude, and 1-8 Hz of responsive frequency as air volume pulse wave.

Ethical Standards

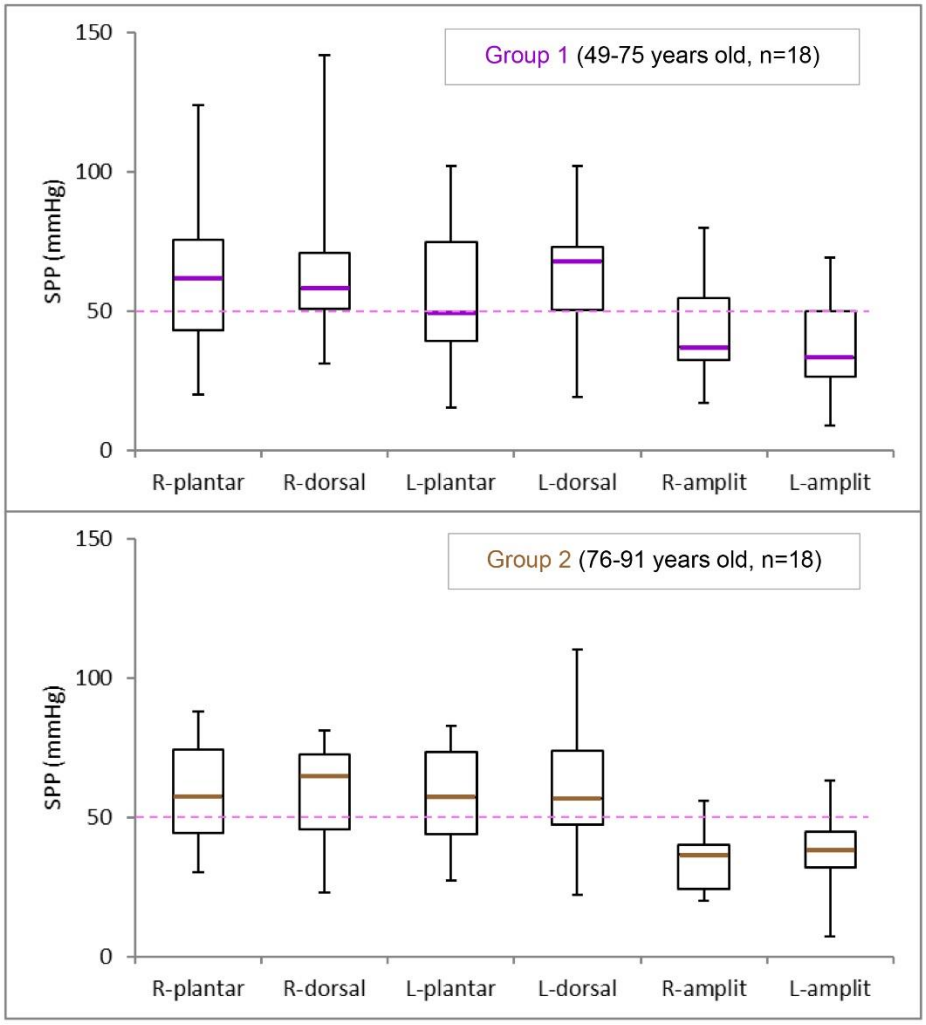
Current protocol complied with the usual ethical guideline for Declaration of Helsinki [11]. In addition, some comments were found with the protected regulation for human information. This principle has been associated with the ethic regulation for actual practice and research for human cases. Some guidelines are informed by Japanese Ministry. It included the Ministry of Health, Labor and Welfare and the Ministry of Education, Culture, Sports, Science Technology, Japan. The authors and collaborators established the ethic committee for this patient, which is in Kanaiso Hospital, Tokushima, Japan. The committee has clinical and also legal personnel, including hospital director, internists, nurse, dietitian, pharmacist, and also legal professional. These members have discussed in satisfactory manner, agreed for the research protocol, and gained the written informed consent from current case.

Results

Current study included 36 HD patients (M/F 24/12), in which general data were analyzed. Their age showed 75.8 +/- 8.9 years old (mean +/- SD) with 76 years old in median. Detail quartile data of 36 cases were summarized in Table 1. The relationship between age and HD duration period was calculated in Figure 1 with negative significant correlation ($p<0.05$). The applicants were divided into 2 groups with 18 cases each (Figure 2).

Younger group with 49-75 years showed wider distribution of SPP values than those of older group with 76-91 years. Furthermore, the applicants were divided into 3 groups with 12 cases each by the HD duration years, in which median value showed 4.9, 10.6 and 22.7 years, respectively (Figure 3).

Figure 2: *SPP results in two age groups.*



In long HD group, SPP values showed the tendency of lower SPP levels than standard range of 50 mmHg. By analyzing the SPP value in left plantar and left amplitude level, short history (Hx) group showed rather scattered distribution, and long Hx group showed small narrower distribution (Figure 4).

Discussion

A meta-analysis with integrated data of some cohort studies showed that decreased ABI (<0.90) would be 1.1% [7]. From international systematic review, PAD has some main risk factors leading to LEAD, including smoking, age, diabetes, hypertension, dyslipidemia and CVA [12]. Among these situations, SPP becomes a reliable biomarker [13]. The interesting report has been found from an epidemiological study in Japan. It was the large study for PAD, named as Surveillance of Cardiovascular Events in Antiplatelet-Treated Arteriosclerosis Obliterans Patients in Japan (SEASON). As a result, prevalence of risk factors for PAD was shown as follows: they are 16.2% for smoking, 61.5% for hypertension, 38.3% for diabetes, 38.8% for dyslipidemia, 29.7% for heart disease, 17.1% for cerebrovascular disease, and 14.3% for CKD [14]. Using WLFI classification, the target limb is evaluated based on three factors of tissue loss, ischemia, and foot infection [15]. CLTI is diagnosed in adults who have been objectively diagnosed with LEAD and who have a variety of clinical symptoms [16].

This study included HD patients undergoing conventional standard treatment. To reflect the situation in daily medical practice, the subjects included 41 HD patients who had undergone

continuous SPP examinations up to the present. However, five HD patients were excluded from the analysis because data on both sides could not be obtained due to PAD in the lower limbs. The data in this study were analyzed for cases with all data available, and the average and median of all 36 cases are shown (Table 1).

Figure 3: *Results of detail SPP in three groups by HD period.*

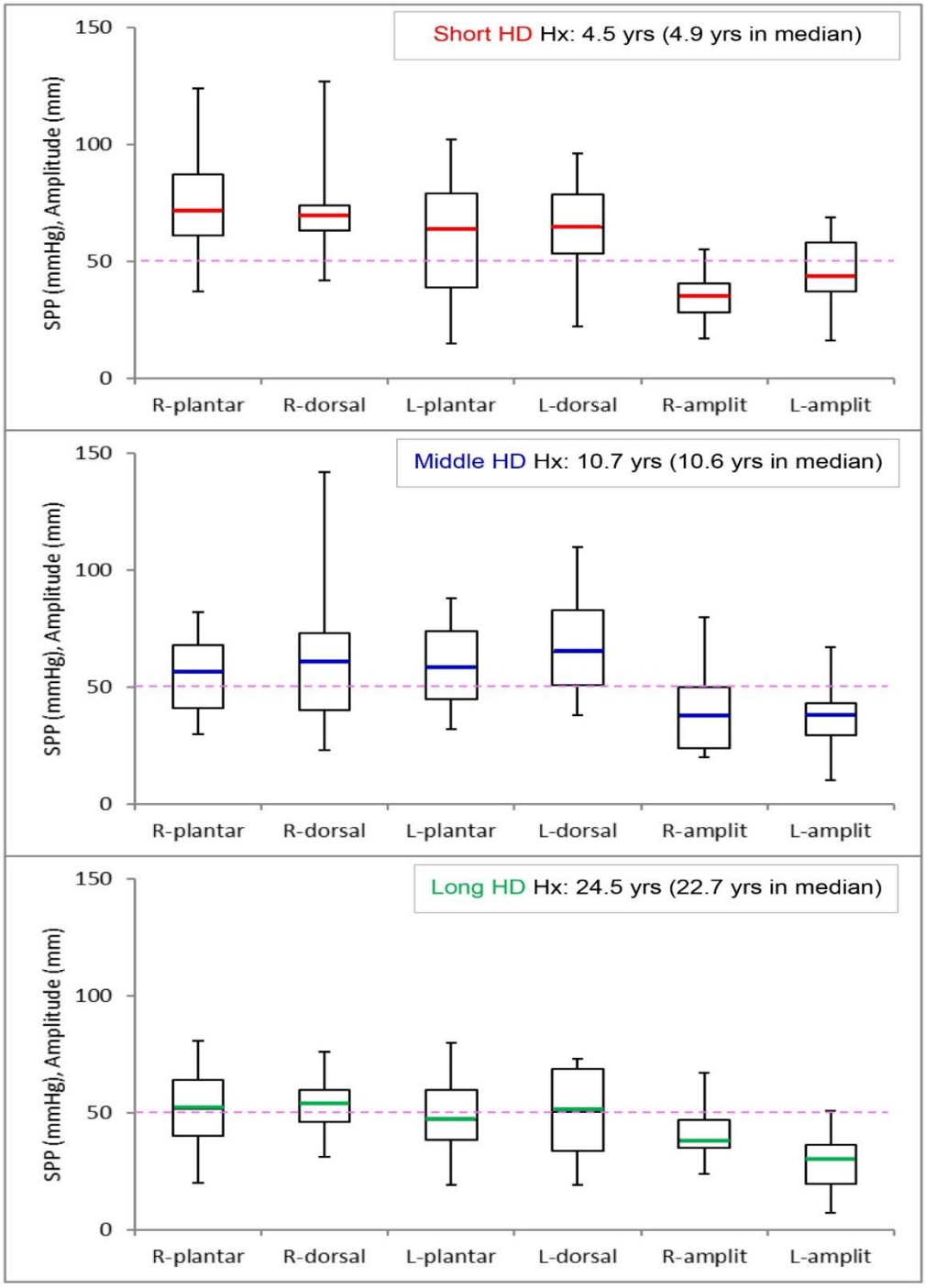
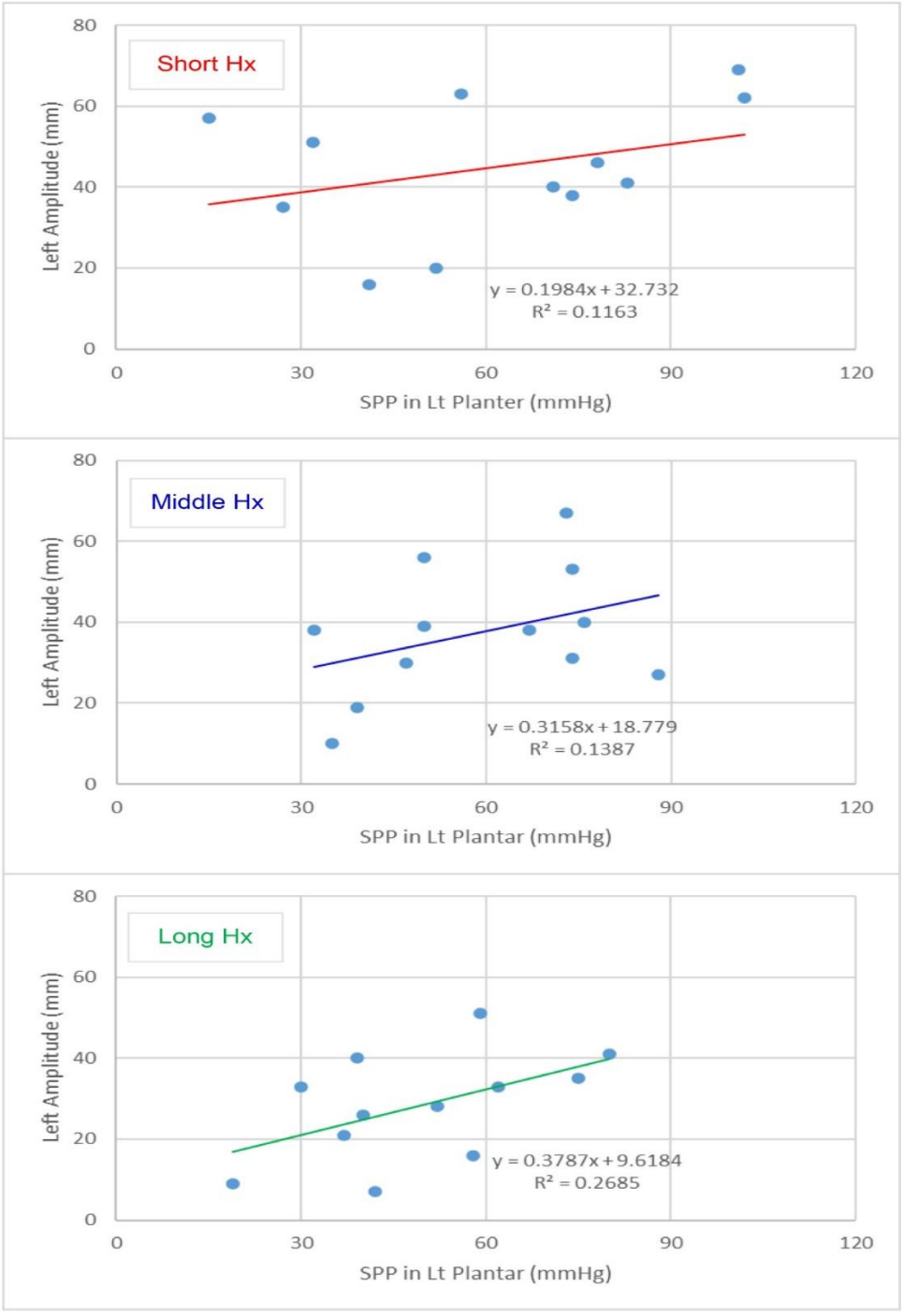


Figure 4: *Correlation between plantar SPP and amplitude.*



Among the relationship between age and HD duration period, several cases were far from the central distribution (Figure 1). This would be due to the causative disease such as diabetes, CKD, and other diseases, and the starting point of dialysis also differed greatly from case to case. Therefore, the distribution of SPP would be wider in the younger group (Figure 2). When divided into three groups by continuing HD period, SPP value and amplitude degree also decreased due to long-term HD (Figures 3,4). These results indicate that the amount of SPP and amplitude data provided may gradually decrease with the prolongation of HD treatment.

Concerning our current data, recent similar reports are observed. For several years, discussion has been observed concerning the cut-off degree of SPP measurements, that is usually 50 mmHg.

By a novel probe of laser Doppler flowmetry (LD), the diagnosis for PAD was studied for 40 cases. As a result, SPP more than 30 mmHg was considered to be adequate for clinical relevant cut-off level [17]. Mutual correlation was studied among SPP, brachial-ankle pulse wave velocity (baPWV), ABI and flow-mediated dilation (FMD) in 80 HD patients [18]. Cases with ABI < 0.95 showed significant lower SPP of both dorsal/plantar feet. Low FMD had significantly lower TG (p=0.033) and higher Ca-P product (p=0.018). Significant associations were observed between dorsal SPP and low ABI (p=0.001)/low baPWV (p=0.036). In contrast, low plantar SPP showed low HDL (p=0.016) and lower ABI (p=0.002). For the relationship between SPP and sarcopenia, 102 T2D cases were investigated [19]. The prevalence of sarcopenia was 11.8%. The ratio of cases with SPP ≤50 mmHg showed 3-folds more than cases with SPP > 50 mmHg as 28.6% vs 9.1%. By multiple logistic regression analysis, cases of SPP ≤50 mmHg showed sarcopenia by odds ratio (ORs) of 4.1.

Some limitations may exist in this report. Current HD patients have various background and comorbidities, and then rather wider distribution in the examined correlation would be related to these aspects. Moreover, the measured results of SPP seem to be fluctuated by the timing of the SPP exam [20]. Consequently, we will follow the future progress for SSP measurement in HD patients with careful attention.

In summary, clinical research of SSP in HD cases with various perspectives was described in the article. PAD in HD would be crucial problem, and adequate management for HD cases will be continued for long. It is expected that this research gives benefit for HD and CKD practice in the future.

Conflict of Interest

The authors declare no conflict of interest.

Funding

There was no funding received for this paper.

References

1. Bando H, Kawata T, Kato Y, Ogura K, Kato Y. Treatment of Oral Semaglutide (Rybelsus) for Diabetic Patient with Past History of Crohn's Disease. Int J Endocrinol Diabetes. 2024; 7: 168.
2. Kato Y, Bando H, Kato Y. Latest Perspectives Concerning Renal Rehabilitation for Chronic Kidney Disease (CKD). J Cardiol Cardiovascular Res. 2021; 3: 112.
3. Fujikawa T, Kato Y, Bando H, Kakutani H, Kawata T, Yamamoto M, et al. The Administration of Xultophy for Diabetic Patients on Hemodialysis. Diab Res Open Access. 2020; 2: 72-78.
4. Norgren L, Hiatt WR, Dormandy JA. TASC II Working Group. Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II). J Vasc Surg. 2007; 45.
5. Howard DP, Banerjee A, Fairhead JF. Oxford Vascular Study. Population-Based Study of Incidence, Risk Factors, Outcome, and Prognosis of Ischemic Peripheral Arterial Events: Implications for Prevention. Circulation. 2015; 132: 1805-1815.
6. Criqui MH, Matsushita K, Aboyans V, Hess CN, Hicks CW, Kwan TW, et al. Lower Extremity Peripheral Artery Disease: Contemporary Epidemiology, Management Gaps, and Future Directions: A Scientific Statement From the American Heart Association. Circulation. 2021; 144: e171-e191.
7. Ohkuma T, Ninomiya T, Tomiyama H. collaborative group for the Japan Brachial-Ankle pulse wave VELocity individual participant data meta-analysis of prospective studies to examine the significance of the Ankle-Brachial Index (J-BAVEL-ABI). Ankle-brachial index measured by oscillometry is predictive for cardiovascular disease and premature death in the Japanese population: An individual participant data meta-analysis. Atherosclerosis. 2018; 275: 141-148.
8. Weaver ML, Hicks CW, Canner JK, Sherman RL, Hines KF, Mathioudakis N, et al. The Society for Vascular Surgery Wound, Ischemia, and foot Infection (WIfI) classification system predicts wound healing better than direct angiosome perfusion in diabetic foot wounds. J Vasc Surg. 2018; 68: 1473-1481.
9. Nakamoto Y. The essence of skin perfusion pressure (SPP). Exams and techniques. 2024; 52: 443-446.
10. PAD4000. Kaneka Medical Product.
11. General Assembly of the World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. J Am Coll Dent. 2014; 81: 14-18.
12. Song P, Rudan D, Zhu Y. Global, regional, and national prevalence and risk factors for peripheral artery disease in 2015: an updated systematic review and analysis. Lancet Glob Health. 2019; 7: e1020-e1030.
13. Kimura T, Watanabe Y, Tokuoka S. Utility of skin perfusion pressure values with the Society for Vascular Surgery Wound, Ischemia, and foot Infection classification system. J Vasc Surg. 2019; 70: 1308-1317.
14. Higashi Y, Miyata T, Shigematsu H. SEASON Investigators. Baseline Characterization of Japanese Peripheral Arterial Disease Patients: Analysis of Surveillance of Cardiovascular Events in Antiplatelet-Treated Arteriosclerosis Obliterans Patients in Japan (SEASON). Circ J. 2016; 80: 712-721.
15. Mills JL Sr, Conte MS, Armstrong DG. The Society for Vascular Surgery Lower Extremity Threatened Limb Classification System: Risk stratification based on wound, ischemia, and foot infection (WIfI). J Vasc Surg. 2014; 59: 220-234.
16. Aboyans V, Ricco JB, Bartelink MEL. Editor's Choice - 2017 ESC Guidelines on the Diagnosis and Treatment of Peripheral Arterial Diseases, in collaboration with the European Society for Vascular Surgery (ESVS). Eur J Vasc Endovasc Surg. 2018; 55: 305-368.
17. Thøgersen KF, Rasmussen KK, Høyer C, Zerahn B. Evaluation of a novel probe based on laser Doppler flowmetry and comparison with photo plethysmography for assessment of the skin perfusion pressure. Scand J Clin Lab Invest. 2022; 82: 238-245.

18. Wung CH, Wang YH, Lee YC, Chang CW, Wu PY, Huang JC, et al. Association between Flow-Mediated Dilation and Skin Perfusion Pressure with Peripheral Artery Disease in Hemodialysis Patients. J Pers Med. 2021; 11: 1251.
19. Jung CH, Cho YY, Choi D, Kim BY, Kim CH, Mok JO. Relationship of Sarcopenia with Microcirculation Measured by Skin Perfusion Pressure in Patients with Type 2 Diabetes. Endocrinol Metab (Seoul). 2020; 35: 578-586.
20. Yamashita Y, Abe Y, Nagasaka S, Yamasaki H, Ishida S, Mineda K, et al. Relationship between fluctuations in skin perfusion pressure values and wound healing in patients with chronic limb-threatening ischemia undergoing hemodialysis. J Med Invest. 2022; 69: 294-298.