Influence of Internal Organ Pathology on Vascular Permeability of Related Skin Zones: An Attempt to Visualize Organ Projection Areas

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ABSTRACT

Objective: Pathology of an internal organ/body part changes electrical features of the corresponding skin areas—organ projection areas (OPAs)—which are often identified with traditional acupuncture points/zones. Once the resistance “breakthrough effect” has been induced in these specific skin areas, rectification of applied electrical currents (a diode phenomenon) occurs. In addition, increased impedance can be observed. It is presumed that these skin bioelectrical phenomena are the result of increased local capillary permeability with extravasation of blood-plasma albumins. Contrast-enhanced magnetic resonance imaging (MRI) of the microvasculature, using labeled albumins as markers, allows visualization of skin areas with higher albumin concentrations. The goal of this research was experimental verification of the abovementioned physiologic hypothesis by visualization of the OPAs.

Materials and Methods: Preselected, comparative, contrast-enhanced magnetic resonance imaging (MRI) studies of the auricular microvasculature were performed in the Division of Diagnostic Radiology of Charlotte Maxeke Academic Hospital in Johannesburg, South Africa, in a group of 42 volunteers with proven clinical conditions of 49 (in total) chosen internal organs/body parts. Previously, 28 auricular OPAs related to internal organs/body parts with proven pathologies showed the abovementioned bioelectrical phenomena and 21 auricular OPAs in a control group did not show those phenomena to a significant extent. Contrast-enhanced MRI assessment of the study participants’ ear auricle vascular permeability was performed after 1, 2, 3, 4, and 5 minutes after a standard contrast, which binds to albumins transiently, was injected intravenously. Contrast-enhanced magnetic resonance images of the diseased body part–related OPAs versus images of the same but healthy body part–related OPAs (control group) were subjected to a final statistical comparison.

Results: It was presumed that 24 OPAs related to internal organs/body parts with serious pathologies were visualized by means of labeled albumins and 25 OPAs corresponding to healthy body parts or minor pathologies were not seen. OPA visibility depended on the extent of pathology within the related internal organ/body part, but not on the kind of organ/body part nor etiology or kind of disease.

Conclusions: Pathology of internal organ/body parts appears to cause higher concentrations of albumins within related OPAs and, in this way, creates specific electrical phenomena observed at the OPAs. Contrast-enhanced MRI of the microvasculature, using labeled albumins, can be useful for visualizing OPAs.

Keywords: acupuncture point, organ electrodermal diagnostics (OED), convergence modulation theory, contrast-enhanced magnetic resonance imaging

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INTRODUCTION

PATHOLOGY OF AN INTERNAL ORGAN/BODY PART changes electrical features of the corresponding skin areas—organ projection areas (OPAs)—which are often identified with traditional acupuncture points/zones (APs). Once the resistance “breakthrough effect” has been induced in these specific skin areas (i.e., a rapid significant resistance decrease due to sufficient levels of voltage and pressure of the negatively polarized point electrode) the rectification of applied electrical currents (a diode phenomenon) occurs.^{1–18} In addition, increased impedance can be observed in respective OPAs.^{1,2,5,7–9,14,16–18} The degree of rectification and the difference in impedance are proportional to the extent of the pathologic process within corresponding body parts; otherwise, there is no dependence on the kind of internal organ or body part nor etiology of the disease.

The convergence modulation theory,^{14,18} which explains various aspects concerning OPAs/APs comprehensively, presumes that these electrical phenomena are caused by an increased local capillary permeability with extravasation of blood-plasma albumins.

Contrast-enhanced magnetic resonance imaging (MRI) of the microvasculature, using labeled albumins, allows visualization of skin areas with higher albumin concentration.²⁰ Therefore, the aim of the study was an experimental verification of the abovementioned physiologic hypothesis by visualization of the OPAs.

MATERIALS AND METHODS

Study Design/Sampling

This preselected comparative study was performed at the Charlotte Maxeke Academic Hospital in Johannesburg, Republic of South Africa, on a group of 42 volunteers in total. The group included 11 men and 13 women, with a mean age of 37 (standard deviation [SD]: 8 years), with clinically proven diseased conditions of one or more of the following internal organs/body parts: esophagus; stomach; colon; gallbladder; pancreas; liver; and breast. These organs/body parts are relatively easy to access clinically (i.e., sufficient clinical data could be obtained easily and cost-effectively to prove the presence of both diseased and healthy conditions). Pathologies of these organs/body parts also represent a variety of etiological and pathogenetic factors (e.g. infections, neoplasms, and inflammation as well as immunologic, metabolic, and mechanical disorders). A total of 28 diseased organs/body parts (4 persons had double pathology) were selected for the study. The control group consisted of 8 men and 10 women, with a mean age of 36 (SD: 9 years), with clinically proven healthy conditions of one or more of the abovementioned internal organs/body parts. There were a total 21 healthy organs/body parts (3 persons had 2 organs/body parts that were proven to be healthy) selected for the study.

All participants underwent a noninvasive electrical evaluation of their respective OPAs in order to confirm the presence of those specific bioelectrical phenomena in OPAs related to diseased organs/body parts, and absence of those bioelectrical phenomena in auricular OPAs corresponding to proven healthy organs/body parts. This was a condition of participation in the subsequent MRI assessment of the OPAs' vascular permeability.

The study was approved by the Human Research Ethics Committee of the University of the Witwatersrand, Johannesburg, Republic of South Africa (clearance certificate M110966). Written consents were obtained from all participants.

Clinical Investigations

Clinical investigations of chosen organs/body parts comprised:

- (1) *Esophagus*—Assessment included history and physical examination, chest radiograph, barium swallow, computed tomography (CT) scan (if indicated), and esophagoscopy with biopsy for confirmation/exclusion of mucosal inflammation or a neoplastic process. Operative findings were included if the patient underwent surgery. For the study, 3 cases of clinically proven healthy esophagus, 2 cases of cancer, 1 case of ulcer, and 1 case of chronic esophagitis were selected.
- (2) *Stomach*—Assessment included history and physical examination, barium meal, CT scan (if indicated), and gastroscopy with biopsy for confirmation/exclusion of mucosal inflammation or a neoplastic process. Operative findings were included if the patient underwent surgery. For the study, 3 cases of clinically proven healthy stomach, 1 case of cancer, 2 cases of ulcer, and 1 case of chronic gastritis were selected.
- (3) *Colon (including appendix)*—Assessment included history and physical examination, barium enema, sigmoidoscopy and/or colonoscopy, full blood count, liver function tests, liver ultrasound (US) examination, and CT scan (if indicated). Operative findings were included, if the patient underwent surgery. For the study, 3 cases of clinically proven healthy colon, 1 case of cancer, 2 cases of acute appendicitis, and 1 case of diverticular disease (in a remission stage) were selected.
- (4) *Pancreas*—Assessment included history and physical examination, serum and urine amylase, acute phase indicators, blood glucose, fecal fats, ultrasound examination, abdominal radiograph, CT scan, and endoscopic retrograde cholangiopancreatography. Operative findings were included, if the patient underwent surgery. For the study, 3 cases of clinically proven healthy pancreas, 2 cases of cancer, and 2 cases of acute pancreatitis were selected.
- (5) *Gallbladder*—Assessment included history and physical examination, acute-phase indicators, liver

function tests, hepatitis markers, urine bilirubin and urobilinogen assessment, US examination, cholecystogram/cholangiogram (if indicated), hepatic immuno-diacetic acid assessment, and cholescintigraphy (if indicated). Operative findings were included, if the patient underwent surgery. For the study, 3 cases of clinically proven healthy gallbladder, 2 cases of acute cholecystitis, and 1 case of asymptomatic gallstones were selected.

- (6) *Liver*—Assessment included history and physical examination, liver function tests, hepatitis markers, urine bilirubin and urobilinogen assessment, protein electrophoresis, autoantibodies assessment, full blood count, prothrombin time, iron studies, US examination, MRI, biopsy, and ascitic tap (if indicated). Operative findings were included, if the patient underwent surgery. For the study, 3 cases of clinically proven healthy liver, 3 cases of active hepatitis B, and 1 case of alcoholic hepatopathy were selected.
- (7) *Breast*—Assessment included history and physical examination, mammography, US examination, breast scintigraphy (if indicated), and MRI (if indicated), as well as histologic/cytologic investigations. Operative findings were included if the patient underwent surgery. For the study, 3 cases of clinically proven healthy breasts, 2 cases of breast cancer, and 2 cases of breast abscess were selected.

All clinical investigations were performed in the course of normal patient care. All the details and the final clinical diagnoses are available in the hospital records.

Electrical Evaluation of Respective OPAs

Only auricular OPAs were used for this study, because each auricular OPA corresponds to only one internal organ/body part,^{1–8,11–13,15–18} in contrast to the corporal APs (classical APs), which might be related simultaneously to quite a few internal organs or other body parts. In addition, the ear auricles are separate thin body parts that do not contain large vessels or bones. It is also very unlikely that ear auricles would undergo any direct injuries, which could produce increased vascular permeability on their own.

Electrical evaluation of the OPAs was performed with a Diagnostics device for organ electrodermal diagnostics (OED; CE Certificate C52113; South African Department of Health License No. 476/8677; Fig. 1), using its direct current measuring modality.¹⁸ This modality automatically estimates the degree of rectification of the measuring electric current once the resistance breakthrough effect has been induced in the skin.* This rapid significant resistance decrease, achieved under specific measuring conditions,^{1,2,5,7,8,14,16–18,20} is the

FIG. 1. Organ electrodermal diagnostics examination by means of a Diagnostics device. The locations of organ projection areas corresponding to examined organs/body parts and diagnostic results (based on the degree of rectification of the measuring current) after the examination is completed are displayed on the screen. Patient shown with permission.

key to obtaining skin resistance measurements that correlate with the conditions of related internal organs/body parts. The device uses optimal measuring parameters selected on the basis of the statistical characterization of the electric resistance and impedance of the OPAs.^{16–18}

The examination entailed placement of the brass reference electrode (2 cm in diameter and covered with a conductive gel) on any area of the patient's skin (e.g., on a hand) and placement of the dry brass point measurement electrode (2 mm in diameter) on the respective OPA (Fig. 2). These specific skin zones were chosen on the basis of the current first author's experience.¹⁹

Depending on the size of a particular ear auricle, OPAs can measure areas from 3 to 10 mm². Therefore, in each case, all the areas had been checked, mm by mm, on both ear auricles, by means of a point measurement electrode applying a constant pressure of ~200 g/cm². Then the highest degree of the measured rectification was presumed as final. The measuring procedures always started with gradually increasing potential of the negatively polarized point electrode until the breakthrough effect was obtained (usually between 7 and 15 V). The current was then adjusted to 25 μ A and the skin resistance was measured.

The polarity of the point electrode was subsequently inverted (set to the same voltage at which the skin resistance measurement was taken but positively polarized) and a second resistance measurement was taken. These 2 measurement values, taken from the same skin point, were used to calculate the rectification ratio, which was not affected by all the factors that influence the absolute (actual) skin resistance values:

$$\text{Rectification ratio} = \left[1 - \frac{(\text{First Measurement})}{(\text{Second Measurement})} \right] * 100\%$$

*Szopiński J, Pastor A. Apparatus for evaluation of skin impedance variations. United States Patent No US 6,633,777 B2, 2003.

FIG. 2. Location of auricular organ projection areas related to: esophagus (1); stomach (2); gallbladder (3); pancreas (4); colon (5); liver (6); and breast (7)—internal aspect of the tragus).

Every time, all the above described measurements and calculations were automatically done within seconds with the Diagnostronics device and then the actual condition of organ/body parts corresponding to the investigated OPAs were estimated as healthy (0%–40% rectification), within normal limits (41%–60% rectification), subacute (61%–80% rectification), or acute (81%–99% rectification). A special percentage display made it possible to specify the degree of rectification of the measuring current more accurately (normal range: 0%–60%).

MRI Assessment of the OPAs' Vascular Permeability

Contrast-enhanced MRI assessment of the study participants' ear auricle vascular permeability was performed, in the Division of Diagnostic Radiology of the Charlotte Maxeke Academic Hospital, with a Siemens Magnetom Avanto MRI machine (Fig. 3). Special MRI sequences were prepared by Siemens technicians to create a three-dimensional (3D) reconstruction of the ear auricles. The first assessment was performed before the contrast dye was injected into the subjects. In order to visualize local capillary leaks with increased albumin concentration, the auricular microvasculature was then assessed after 1, 2, 3, 4, and 5 minutes, after a

FIG. 3. Contrast-enhanced magnetic resonance imaging assessment of the vascular permeability of the ear auricles: Examination is in process.

standard MultiHance® MRI contrast (Bracco [Pty] Ltd.), which binds transiently to albumins, was injected intravenously. Obtained in this way, contrast-enhanced MRI images of the diseased body part-related OPAs versus images of the same but healthy body part-related OPAs (control group) were subjects for the final statistical comparison. A χ^2 test with the Yates' continuity correction was used to calculate statistical significance. $P < 0.05$ was accepted as the statistically significant difference.

RESULTS

All patients with proven pathologies had specific bioelectrical phenomena in their respective auricular OPAs, with the degree of rectification being proportional to the intensity of the pathologic processes (Table 1). None of the control group patients had those phenomena to a significant extent in their respective OPAs. There was no significant statistical difference between the measurement results obtained on the left and right ear auricles, even in the case of unilaterally located organs, such as the gallbladder or the liver. The measurement results did not depend on the kind of organ/body part and were not affected by either the type or etiology of the disease. It was noted that the measurement results were also not influenced by a patient's muscular tension, emotional state, skin humidity, environmental temperature, or procedure duration. The pressure of the measuring electrode had a limited influence (up to 5%) on the results and did not affect final estimations. The measurements did not cause any unpleasant sensations. No side-effects were noted.

Fig. 4(A–H) shows exemplary images of ear auricles obtained via MRI 5 minutes after the contrast dye was injected. It was noted that the best visibility occurred at that time. On these images, areas of higher albumin concentrations

TABLE 1. CLINICAL DIAGNOSES AND DEGREES OF ELECTRICAL RECTIFICATION (NORMAL RANGE: 0%–60%) MEASURED IN RESPECTIVE OPAs VERSUS RESULTS OF CONTRAST-ENHANCED MRI ASSESSMENT OF THE OPAs

Clinical diagnosis	Subjects (organs/body parts)	OPA electrical rectification				OPA visualization	
		Healthy range		Diseased range			
		0%–40%	41%–60%	61%–80%	81%–99%	Unmarked	Marked
Esophagus							
Healthy	3	2	1			3	
Esophagitis	1			1		1	
Ulcer	1				1		1
Cancer	2				2		2
Stomach							
Healthy	3	1	2			3	
Gastritis	1				1		1
Ulcer	2				2		2
Cancer	1				1		1
Colon							
Healthy	3	2	1			3	
Diverticular disease	1			1		1	
Appendicitis (acute)	2				2		2
Cancer	1				1		1
Pancreas							
Healthy	3	2	1			3	
Pancreatitis (acute)	2				2		2
Cancer	2				2		2
Gallbladder							
Healthy	3	3				3	
Gallstones	2			1	1	1	1
Cholecystitis (acute)	2				2		2
Liver							
Healthy	3	1	2			3	
Hepatitis B	3			1	2	1	1
Alcoholic hepatopathy	1				1		2
Breasts							
Healthy	3	1	2			3	
Abscess	2				2		2
Cancer	2				2		2
Total	49	21		28		25	24

Note: Marked OPAs distinguish subjects with disease from healthy subjects with a statistical significance of 1.6e-08.

OPA, organ projection area; MRI, magnetic resonance imaging.

are marked as bright patches. As anticipated, there was a strong background of small vessels present, which made it difficult to identify the suspected OPAs clearly. The hypothetical albumin leaks were expected, nevertheless, to be minimal, compared to the albumin volumes carried by the

vessels. However, by viewing different angles of the ear auricle 3D reconstructions on the computer screen, it was possible—at least to a certain extent—to distinguish the vessels from those other respective areas of higher albumin concentration. Unfortunately, due to technical limitations,

FIG. 4. (A) Contrast enhanced magnetic resonance imaging (MRI) of the auricular vasculature of the clinically healthy 24-year-old male (left ear auricle). (B) Contrast enhanced MRI of the auricular vasculature of the 29-year-old female with a gallstone (right ear auricle). (C) Contrast-enhanced MRI of the auricular vasculature of the 33-year-old female with stomach ulcer (left ear auricle). (D) Contrast-enhanced MRI of the auricular vasculature of the 33-year-old female with esophageal cancer (right ear auricle). (E) Contrast-enhanced MRI of the auricular vasculature of the 30-year-old female with acute appendicitis (right ear auricle). (F) Contrast-enhanced MRI of the auricular vasculature of the 51-year-old male with acute pancreatitis and alcoholic hepatopathy (left ear auricle). (G) Contrast enhanced MRI of the auricular vasculature of the 47-year-old male with a distal colon cancer (left ear auricle). (H) Contrast enhanced MRI of the auricular vasculature of the 39-year-old female with right breast cancer (right ear auricle). OPA, organ projection area.

the two-dimensional photographs are shown in this article (Fig. 4), as these dynamic 3D images could not be shown here.

Nevertheless, in total, 24 of 28 OPAs related to diseased internal organs/body parts were presumed to be visualized (marked by labeled albumins) by means of the contrast-enhanced MRI (Table 1). All of the OPAs related to internal organs/body parts with serious pathologies were presumed to be visualized. In most cases, these OPAs were more visible on the ear auricle on the side of the respective internal organ/body part (i.e., on the right ear auricle for the gallbladder and on the left auricle for left breast pathology). Otherwise, there was no dependence observed on the kind of organ or etiology of the disease. OPAs corresponding to healthy body parts or minor pathologies were not seen (unmarked).

DISCUSSION

There is a lot of controversy surrounding the existence of OPAs/APs on the skin surface. They are, however, widely used in physical medicine for therapeutic purposes, for example, in acupuncture, acupressure, analgesic electrostimulation (transcutaneous electrical nerve stimulation), laser therapy, magnet therapy, reflexive thermotherapy (moxa, cryotherapy), and reflexology (reflexive massage of the feet). When pathology occurs in corresponding internal organ/body parts, these skin areas become tender (more sensitive to physical pressure).¹⁸ They also start to manifest specific electrical changes that are utilized by the OED—the first clinically proven diagnostic method^{4,5,8,10,13,17,18} that has a noninvasive way to access precise diagnostic information circulating in the sensory nervous system.^{14,18}

The convergence modulation theory^{14,18} explains both therapeutic and diagnostic aspects of OPAs/APs comprehensively. It presumes that, due to the specific structure of the sensory nervous system, nervous afferent signals sent from damaged organs to the central nervous system could also reach, in an antidromic way, certain skin areas^{14,18} (making these OPAs more sensitive to physical pressure). Nervous signals reaching local free nerve endings would cause them to release neuropeptides to the intercellular fluid of the innervated epidermal areas.^{21–25} Higher concentrations of neuropeptides would cause, in turn, vasodilatation and increased capillary permeability in the vicinity of free nerve endings, leading to extravasation of blood plasma protein molecules (mainly albumins).^{21,24,25} Intercellular fluid has a similar composition to blood plasma, except that the concentration of proteins in blood plasma is much higher than in intercellular fluid. Higher local concentrations of negatively charged albumin molecules—which can block the ionic current epidermal passages—would be responsible for the electrical phenomena observed at the skin surface.^{14,18}

Using labeled albumins for contrast-enhanced MRI of the microvasculature, the present study seems to confirm the abovementioned physiologic presumptions. The images obtained could be the first-ever visualizations of the OPAs and, in general, the APs. However, the OPAs' visibility was assessed subjectively against the background of vessels. In addition, the principles of blinded study were not followed (this was a pilot study). Therefore, to be certain about these study results, researchers would probably have to wait until suitable neuro-mediator markers became available. Such markers would eliminate the current problem of background images and could finally produce very clear, proven images of the OPAs/APs.

CONCLUSIONS

First, the present study confirmed that OPAs do exist on the skin surface. Pathology of corresponding internal organs/body parts causes these skin areas to rectify applied electrical currents (a diode phenomenon) once the resistance breakthrough effect has been induced in the skin. The degree of such an electrical rectification is proportional to the extent of pathologic processes within related organs/body parts but does not depend on the kind of organ/body part or the etiology or kind of disease.

Second, the study results indicate that the pathology of an internal organ/body part causes a higher concentration of albumins within related OPAs. This could be the result of an increased local capillary permeability with extravasation of blood-plasma albumins. Higher local concentrations of albumin molecules could be responsible for the specific electrical phenomena observed at the OPAs.

Third, contrast-enhanced MRI of the microvasculature, using labeled albumins, can be useful for visualizing OPAs. OPA visibility seems to depend on the extent of pathology within the related internal organ/body part, but does not depend on the kind of organ/body part or etiology or kind of disease.

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AUTHOR DISCLOSURE STATEMENT

No competing financial conflicts exist.

REFERENCES

1. Szopiński J, Sierak T, Niezbecki A, Kaniewski M. Influence of selected internal diseases on electrical parameters of acupuncture points [in Polish]. In: Sapinski W, ed. *Proceedings of 1st National Conference on Acupuncture*. Warsaw/Kalisz: WSZ; September 23–24, 1982:54–69.
2. Szopiński J, Sierak T, Szopinska H, Ciszek M. Bioelectrical and bioenergetic properties and morphological structures of the acupuncture points and acupuncture meridians. In: Bischko J, ed. *Handbook of Acupuncture and Auriculotherapy, part 25.2.0*. [in German] Heidelberg: Haug Verlag; 1985:105–124.
3. Ciszek M, Szopiński J, Skrzypulec V. Investigations of morphological structure of acupuncture points and meridians. *J Tradit Chin Med*. 1985;5(4):289–292.
4. Szopiński J. Application of the organ electrodermal diagnostics own method in chosen internal diseases [in Polish; Ph.D. thesis]. Katowice, Poland: Medical University of Silesia; 1985.
5. Sierak T, Szopiński J. Universal device for organ electrodermal diagnostics and electrotherapy [in Polish]. *Probl Tech Med*. 1987;18(4):255–262.
6. Szopiński J, Sierak T, Gabryel A. The investigation of the bioenergetic properties of the acupuncture meridians [in German]. *Dtsch Z Akup*. 1988;31(2):31–35.
7. Szopiński J, Sierak T, Kaniewski M, Niezbecki A. The influence of selected diseases on the bioelectrical properties of the acupuncture points [in German]. *Dtsch Z Akup*. 1988;31(3):51–55.
8. Sierak T, Szopiński J. Universal electronic device for the automatic electroacupuncture diagnostics and electrotherapy [in German]. *Dtsch Z Akup*. 1988;31(5):112–115.
9. Szopiński J. The use of bioelectrical properties of skin for diagnosing organ disease [in Polish]. *Wiad Lek*. 1989;42(10):697–702.
10. Szopiński J, Pantanowitz D, Jaros GG. Diagnostic accuracy of organ electrodermal diagnostics: Pilot study. *S Afr Med J*. 1998;88(2):146–150.
11. Szopiński J, Lukasiewicz S, Lochner G, et al. Influence of general anesthesia and surgical intervention on the electrical parameters of auricular organ projection areas. *Med Acupunct*. 2002;14(2):40–42.
12. Szopiński J, Lochner G, Szkliniarz J, et al. Localization of auricular projection areas of the stomach and duodenum and their use in the monitoring of ulcer disease. *Med Acupunct*. 2003;15(1):31–34.
13. Szopiński J, Pantanowitz D, Lochner G. Estimation of the diagnostic accuracy of organ electrodermal diagnostics. *S Afr Med J*. 2004;94(7):547–551.
14. Szopiński J, Sierak T, Lochner G. Neurophysiological foundations of organ electrodermal diagnostics, acupuncture, TENS and other reflexive therapies. *S Afr J Anaesth Analg*. 2004;10(3):21–27.
15. Szopiński J, Lochner G, Macura T, et al. Localization of auricular projection area of the liver and its use in the monitoring of viral hepatitis. *J Tradit Chin Med*. 2006;26(4):260–265.
16. Szopiński J, Lochner G, Pantanowitz D. Influence of organ pathology on the electrical parameters of organ projection areas of the skin. *J Tradit Chin Med*. 2006;26(3):218–225.
17. Szopiński J. Estimation of the diagnostic accuracy of organ electrodermal diagnostics [MSc(Med) dissertation]. Johannesburg: University of the Witwatersrand; 2006.
18. Szopiński J. *The Biological Action of Physical Medicine: Controlling the Human Body's Information System*. New York: Elsevier Academic Press; 2014.
19. Vandoorne K, Addadi Y, Neeman M. Visualizing vascular permeability and lymphatic drainage using labeled serum albumin. *Angiogenesis*. 2010;13(2):75–85.
20. Lochner G. The voltage–current characteristic of the human skin [Master's dissertation]. Pretoria; University of Pretoria; 2003.
21. Brain SD, Newbold P, Kajekar R. Modulation of the release and activity of neuropeptides in the microcirculation. *Can J Physiol Pharmacol*. 1995;73(7):995–998.
22. Lotti L, Hautmann G, Panconesi E. Neuropeptides in skin. *J Am Acad Dermatol*. 1995;33(3):482–496.
23. Misery L. Neuro-immuno-cutaneous system (NICS) [in French]. *Pathol Biol (Paris)*. 1996;44(1):867–874.
24. Traczyk W, Trzebski A. *Human Physiology with Elements of Applied and Clinical Physiology* [in Polish]. Warsaw: Wydawnictwo Lekarskie PZWL; 2001.
25. Vander A, Sherman A, Luciano D. *Human Physiology*, 7th ed. New York: WCB McGraw-Hill; 1998.

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