

Measurement of Electrical Resistance of Dermal-Visceral Zones as a Diagnostic Tool for Gynecologic Disorders

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ABSTRACT: **Background:** Non-invasive screening tests may allow early diagnosis and prompt treatment, thereby potentially reducing morbidity and mortality and reducing costs for the community. This may be especially important for gynecologic pathologies that are difficult to promptly diagnose, such as endometriosis or ovarian cancer.

Objectives: To evaluate the reliability of measuring skin resistance using the Medex Test for screening and diagnosis of gynecologic pathologies in a blinded single-center study.

Methods: We enrolled 150 patients: 59 with a functional disorder and 91 with an organic disease. Measurements were carried out in all patients and the results were analyzed separately by a second physician who was blinded to the patients' diagnosis.

Results: A high correlation was found between the clinical diagnosis and the results of the measurement of electrical skin resistance, with a specificity of 76.3% (45/59) for functional disorders and a sensitivity of 85.7% (78/91) for organic disorders, positive predictive value of 84.8% (78/92) and negative predictive value 77.6% (45/58). The kappa value for the results was 0.622, representing a value much better than expected randomly.

Conclusions: The Medex Test has a good specificity and a high sensitivity for the diagnosis of gynecologic disorders. Further prospective studies are needed to validate these preliminary findings.

IMAJ 2010; 12: 334–337

KEY WORDS: diagnostic test, skin electrical resistance, screening tool, gynecologic pathologies

The importance of screening tests is well established in modern medical practice [1,2]. A new screening test was recently proposed based on measuring skin electrical resistance of predetermined dermal-visceral zones [3-8]. The rationale behind the system is that internal organs correspond, perhaps through fibers of autonomic nervous system and common spinal tracts, to specific skin zones on the trunk and limbs (reflex arc). Thus, pathologic processes in an internal organ – such as a neoplasm, an infection or any other disorder – change the physiologic status of the internal

organ (e.g., quantity and ratio of intracellular and extracellular fluids and electrolytes, intensity of metabolism), as well as physical parameters of specified organs (bio-impedance). As a result, a pathologic electrical impulse from a specific organ may be transferred through the reflex arc to the corresponding DVZ [9-11]. By measuring the electric resistance of DVZs, it should be possible to diagnose internal disorders prior to clinical presentation.

Measuring electric skin resistance is by no means a new technique, but only recently did researchers put it to the test of controlled prospective/retrospective studies. Many devices are currently used in medical practice for bio-impedance measurements, such as electrogastrography, electrical-impedance tomography, the T-Scan non-invasive breast cancer test, and measurement of cardiac output. The use of bio-impedance diagnostic equipment is of growing scientific and medical interest.

Several recent studies demonstrated, in a varied population of a few hundred patients, that the “Medex Test” galvanic skin measurement device has a sensitivity and specificity of over 80% [3-8]. Furthermore, the difference in resistance between subjects was proportional to disease severity [4]. Although its mechanism of action is not yet well established, the measurement of skin resistance seems to have a screening potential for a wide range of internal disorders, as diverse as viral hepatitis, cancer and various respiratory disorders. As the technique is easy to use and interpret, reproducible, has no known side effects and is not invasive, its potential cannot be ignored.

In this study, we examined the skin resistance of 150 women, some with internal diseases and others with functional problems and no identifiable organic disorders. Our goal was to evaluate the reliability of measuring skin resistance for screening and diagnosis of gynecologic pathologies and to examine whether the technique can differentiate organic disease from functional disorders.

PATIENTS AND METHODS

The study, designed as a blinded, case-control, comparative study, was conducted in the Department of Obstetrics and

DVZ = dermal-visceral zones

Gynecology at Sheba Medical Center, Israel in 2006. Patients were recruited by the site coordinator. A physician-gynecologist assessed the participants for eligibility and an informed consent was signed. All patients underwent a baseline evaluation, which included demographic and medical history, medications, physical examination and routine blood and urine analyses, which were necessary for initial diagnosis. The participants did not undergo specific blood tests as part of the enrollment in this study; however, the results of past additional tests were analyzed according to common practice and type of disease. Tests for a hormone profile included follicle-stimulating hormone, luteinizing hormone, estradiol, prolactin, progesterone, beta-human chorionic gonadotropin. Pelvic and vaginal ultrasound, color-flow Doppler ultrasound, hysteroscopy, and biopsy were also performed. Participants with an initial diagnosis of premenstrual syndrome or menopause completed a specific questionnaire. All patients were referred for a Medex Test (Medex Screen Ltd., Arad, Israel), which was conducted by specialized technicians who did not know the patients' diagnosis. The results were analyzed separately by an independent physician who was also blinded to the patients' diagnosis.

After the required data were obtained from all study participants at Sheba Medical Center, the results of the Medex Test were compared with the actual participant's condition as indicated by the traditional tests, in order to determine the sensitivity, specificity and total accuracy of the device.

STUDY POPULATION

Patients with clinically documented organic gynecologic disorders were enrolled. All cases of cancer were diagnosed based on pathologic analysis. Non-organic gynecologic disorders were defined as a positive medical history based on patients' presenting complaints, clinical symptoms of disease, and absence of objective clinical findings of an organic gynecologic disorder. Other inclusion criteria included age not younger than 18 and willingness to participate, as evidenced by signing the written informed consent form.

There were only two exclusion criteria: amputees and local skin damage in the area of measurement.

ELECTRIC SKIN RESISTANCE MEASUREMENT

The device described in this study, which was developed by Medex Screen Ltd. (Arad, Israel), consists of an active electrode (handheld, pressure operated, non-invasive), a passive electrode (held by the patient in the opposite hand) and software. With the device, a low, unfelt, direct electric current is applied to measure skin resistance (in kOhm) in skin areas called dermal-visceral zones. Before testing, the sensors and the passive electrodes that touch the skin are cleaned with a 70% ethyl alcohol solution. The DVZs on the patient's skin are also cleaned with 70% ethyl alcohol solution to avoid the

possibility of sebum, humidity or impurities, which may be present on the skin, influencing the results of the test. The technician then locates the 24 DVZ zones on the hands and feet (according to technology of Medex Screen, patent number US 6,934,581) and measures the skin resistance using the active electrode. There are six zones on each limb. Before applying the sensor, each skin zone is treated with a 0.9% sodium chloride solution.

After measurement of the 24 zones, the DVZs are stimulated using an electronic TENS device, which is legally marketed in the United States and Europe. This device is intended for pain relief by transcutaneous electrical stimulation. The stimulator acts on specific DVZs on the extremities (four zones) for 1 minute (100 Hz, 25 mA). After stimulation of the DVZs the artifact effect on the patient's skin resistance is eliminated. The effect of this stimulator test lasts for about 5 minutes, during which the operator repeats the measurement of the 24 zones on the extremities. The measurements are processed by the device software. The normal value range is created by incorporating the patient's measurements into a preset algorithm. Deviations from the normal range are recorded and studied in order to reach a diagnosis of the organic or non-organic gynecologic disorder.

The mechanisms behind the measurements obtained remain to be determined. It has been speculated, however, based on previous observations regarding acupuncture stimulation, that stimulation of predetermined skin zones may result in activation of the hypothalamus and nucleus accumbens and deactivation of the rostral part of the anterior cingulate cortex, amygdala formation and hippocampal complex [12]. Such influence on brain formation could stimulate internal organs and allow differentiating between functional artifacts (digestion of fatty food, concurrent use of antibiotics, or alcohol in the bloodstream) and organic disorders of the internal organs.

SAFETY CONSIDERATIONS

The electrical measurements are performed with an electric current of up to 20 μ A (voltage 5 V) lasting approximately 0.5 seconds. This low electric current is considered very safe and is not associated with skin damage.

ETHICAL CONSIDERATIONS

The study was approved by the hospital's Helsinki Committee for clinical investigations. All patients provided written informed consent prior to entering the study.

STATISTICAL ANALYSIS

Statistical analysis was conducted using the SPSS for Windows 10.0 program. The Medex Test diagnosis was statistically compared and estimated agreement with the results obtained from conventional diagnostic methods. A standard measure

of agreement (Cohen Kappa) between the two variables was estimated. In addition, all measures of agreement (sensitivity, specificity, positive and negative predictive values) for the Medex Test diagnosis were calculated using the conventional diagnosis as the gold standard. *P* values < 0.01 were considered significant. A two-tailed binomial test was used for specific pathologies and disorders. To achieve a significance level of 95%, a sample size of 150 evaluable subjects was considered sufficient for estimation of Kappa 90–100%.

RESULTS

We enrolled 150 patients admitted to our gynecology department or visiting the outpatient clinic: 59 patients with a pure functional disorder (premenstrual syndrome or genuine stress incontinence), age 19–73 years (average age 38, SD 11.9); and 91 with an organic disease (uterine myoma, uterine polyp, ovarian cyst, endometriosis, cervical and uterine cancer), age 21–86 (average age 52, SD 15.8) diagnosed before the study began.

Of the 150 patients who participated in the study, 59 had functional problems and 91 had various organic pathologies. Of the 91 patients with organic pathologies, 33 had gynecologic cancer, 20 had ovarian cysts, 19 had myomatous uterus and 19 had various pelvic pathologies [Table 1]. Of the 59 patients with functional problems, 46 had PMS, 7 had genuine urinary stress incontinence and 6 had menstrual migraine [Table 2].

The Medex Test, using the protocol described above, had a sensitivity of 85.7% (78/91) and a specificity of 76.3% (45/59). The positive predictive value was 84.8% (78/92), and the negative predictive value 77.6% (45/58). The Kappa value for the results, as calculated by SPSS, was $\kappa = 0.6218$, representing a value much better than that expected for a random association [Table 3].

PMS = premenstrual syndrome

Table 1. Diagnosis by electrical skin resistance of dermal-visceral zones of various organic pathologies

Pathology	Diagnosed as an internal pathology	Diagnosed as a functional disorder
Pelvic inflammatory disease	4	1
Uterine myoma	15	4
Ovarian cyst	18	2
Ca of cervix	7	1
Ca of uterus	14	0
Ca of ovary	11	0
Endometriosis	2	1
Vulvar lesion	1	1
Uterine prolapse	9	0

Table 2. Diagnosis by electric skin resistance of dermal-visceral zones of various functional disorders

Functional disorder	Diagnosed as an internal pathology	Diagnosed as a functional disorder
PMS	6	40
Menstrual migraine	3	3
Urinary stress incontinence	0	7

Table 3. Study results – diagnosis based solely on skin resistance measurements

Type of disorder	Diagnosed as a functional disorder	Diagnosed as an internal pathology	Kappa value
Functional disorder (59 patients)	45	14	$\kappa = 0.618$
Internal pathology (91 patients)	13	78	

DISCUSSION

Gynecologic pathologies are frequently associated with non-specific complaints. There is clearly an urgent need for more efficient non-invasive methods to assist the gynecologist in the early screening of both benign and malignant disorders. An early diagnosis can prevent morbidity and mortality, while an efficient non-invasive screening tool can prevent unnecessary examinations, which are costly, uncomfortable for patients, and have potential side effects. Such is the case with pathologies as different as endometriosis and carcinoma of ovary [13–15].

A disease diagnosed in its early stages can often be cured or controlled by relatively simple means, while late diagnosis often leads to more radical procedures that would not be required had the disorder been identified sooner. Therefore, screening tests play an increasing role in modern medicine, and the search for new effective screening methods has gained importance.

A screening test must have several characteristics. It has to have good sensitivity and specificity for the relevant disease. It has to have minimal side effects. It has to be easy to use and interpret. And, for obvious reasons, it has to be inexpensive.

Swift diagnosis and treatment – or ruling out a relevant diagnosis – is crucial for patients and physicians alike. While this is true for most disciplines, the importance of an efficient screening tool is especially important for the community gynecologist. Diseases such as endometriosis or ovarian cancer, both common diseases, usually cause non-specific complaints (if at all) in preliminary stages. Retrospective studies have shown that 95% of women with ovarian cancer have symptoms prior to diagnosis [16]. Diagnosis tends to be

late, when the disease is disseminated and prognosis poor. A good screening tool could help the gynecologist decide which women should undergo follow-up, and which are at risk for an occult disease and should undergo further tests [17]. So far no screening tool was found to be cost effective; even annual screening by transvaginal ultrasound was found in a recent large-scale study to have limited benefit as a screening modality [18].

Our study demonstrated that the technique of electric skin resistance measurement may have merit as a screening tool for gynecologic complaints and disorders. Kappa value for the technique in our study was $\kappa = 0.6218$ for differentiating functional disorders from various internal pathologies, suggesting a good correlation between the technique's diagnosis and the true diagnosis. The most impressive, and clinically relevant, results were for screening for gynecologic malignancies: 32 of 33 carcinomas were suggested by the device as serious organic gynecologic diseases, and 11 of 11 ovarian carcinomas [Table 1]. Prospective double-blind studies are required to further validate these results.

The study was based on patients with an established diagnosis. Thus, its cross-sectional nature limited its effectiveness. Furthermore, statistical analysis compared women with pelvic pathologies to women who had functional problems. We did not enroll healthy non-symptomatic women who could have served as the most appropriate control group for a potential screening device. The definitions used in the study are somewhat problematic, since a 'functional' disorder could have an organic cause. PMS is not a straightforward diagnosis, but rather a variety of complaints and symptoms. Myomatous uterus is an organic pathology that could cause functional disturbances, and urinary incontinence might result from purely 'organic' causes. Some of the women with internal pathologies who participated in the study had an advanced disease beyond the need for screening. It is clear that many women with pathologies such as ovarian cysts and uterine polyps are not diagnosed, while the patients enrolled in our study were admitted to the hospital for the management of these pathologies. Finally, the study groups were not matched for age, risk factors and other confounders. Nevertheless, the findings do show a high correlation between electric skin resistance and the existence of internal pathologies, especially malignancies, which should be explored.

Prospective double-blind studies are needed to further validate these data. Once the data are validated more studies should be performed to determine specific indications, strength points and weaknesses of the technique, as the mechanism of action has yet to be fully elucidated. Measuring the skins' electric resistance still has a long way to go from its present state to clinical bedside use as a general screening modality. However, we feel that the technique is

worth exploring, since its potential as a screening method for possible malignancies is exciting, in terms of both basic science and clinical medicine.

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