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Selected Abstract Presentation 1

The heart function after destruction of the epicardial nerve subplexuses of the right atrium

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The aims of this study were to investigate the topography of the intracardiac nerve subplexus and to estimate its action on the sinoatrial (SA) and atrioventricular (AV) nodes as well as the possibilities of its selective denervation. For electrophysiologic studies, we used mongrel dogs. Thoracotomy was performed in the left fourth intercostal space. Two bipolar suction electrodes for stimulation and electrocardiogram recording were fixed on the right atrium and on the left ventricle. The cervical vagosympathetic trunk and ansae subclaviae were isolated. Heart zone and nerve subplexus destructions were performed by cryoablation. In the first series of experiments, the destructions were performed in the zones around the superior vena cava (ventral, lateral, and dorsal); in the second series, these were performed in the left posterior and midseptal nerve plexus zones. The SA node activity, SA node function recovery time, pulse propagation time from atria to ventricles, and effective refractory period of the atria and AV nodes were measured.

Results and conclusions: Our electrophysiologic studies suggest that the function of the SA node can be modified with the destruction of the ventral, lateral, and dorsal zones. The changes in electrophysiologic parameters after intracardiac nerve subplexus destruction show that destruction of the ventral and lateral zones modifies the effects of the sympathetic tone to the SA node. Destruction of the dorsal zone modifies the effects of the vagus nerve to the SA node. The data from the second series of experiments show that the AV node is reached only by parasympathetic fibers of the left posterior and midseptal nerve plexuses. After its destruction, the selective parasympathetic denervation of the AV node is possible to achieve. In addition to the 2 nerve plexuses, some other plexuses comprising sympathetic fibers that reach the AV node were present. It is necessary for surgeons to be aware of the possible changes in SA and AV node functions and to avoid manipulations in these zones while performing interventions or ablations in the zones of nerve plexuses.

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Holter monitoring data in predicting the general health status of older adults

M. Shkolnikova [a]

Two hundred one participants (age range, 67-86 years) were selected randomly from among the survivors of the Moscow Lipid Research Clinic cohorts recruited in 1975-1983 as part of the clinic's prevention program for atherosclerosis. Biomedical and interview data were collected for this group in 2002-2003. The study protocol included anthropometry; physical performance tests; measurements for blood pressure, total and high-density lipoprotein cholesterol, body mass index, 12-hour urinary cortisol, and epinephrine as well as norepinephrine excretions; electrocardiography; and 24-hour Holter monitoring. Holter monitoring was performed using a 2-channel system MT-200 system (Schiller, Baar, Switzerland) in accordance to the 1999 American Heart Association guidelines. Participants were monitored for 24 hours and were encouraged to continue their normal daily activities. The analysis of heart rate variability (HRV) was performed on the digitized data in accordance to the guidelines of the Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. Records with less than 20 hours of analyzable data as well as data from individuals with atrial fibrillation or implanted pacemakers were excluded. Holter monitoring data of sufficient quality and duration were available for 185 individuals. The principal health outcomes were self-rated health, mobility limitations, score of diseases, grip strength, stress score, and immediate recall score (Table 1). The health outcomes were predicted by regression models with control for age and sex. Global self-rated health was measured by asking the participants how they consider their health in general with a 5-scale response option from "excellent" to "very poor." Mobility limitations were evaluated as the number of reported difficulties in walking around, climbing up stairs, staying outdoors, and walking outdoors without resting. Right grip strength is an objective measure of physical functioning (isometric muscle strength). It was obtained with the use of a handheld dynamometer (Smedley's Dynamometer TTM, Tokyo, Japan). The score of diseases was calculated as the number of reported diseases/disabilities ranging from 1 to 14. The stress score was based on a 10-item set of questions related to perceived life problems, ability to cope with them, ability to manage and keep things in one's life under control, feeling of nervousness, and overwhelming difficulties. Brief individual tests of immediate recall were used to assess cognitive functions. Immediate recall was estimated as the number of words (of 12) that a respondent was able to remember after a list was read by the interviewer. Conventional, Framingham, and Holter risk scores were calculated from the collected data. The conventional risk score was based on established risk factors such as smoking, grip strength (excluded in regression with the right grip strength as a dependent variable), forced vital capacity of the lungs, and high (>168 mm Hg) systolic blood pressure. The association between mobility limitations, number of reported diseases, grip strength, stress score, immediate recall, and the Framingham, conventional as well as Holter risk scores was examined using ordinary least squares and logistic regression models controlled for age and sex.

Two Holter risk scores were constructed on the basis of exploratory regression of health outcomes on a variety of Holter parameters, including mean, maximum, and minimum heart rate values; HRV time and frequency domain parameters; arrhythmia characteristics; and dynamics of heart rate during awakening. Parameters with stronger correlations with health outcomes and with low intercorrelations were selected. The first Holter risk score included a small increase in the heart rate during awakening (<20 bpm), a low circadian index, a ratio of the daytime and nighttime average heart rates (<1.2), indexes of ventricular arrhythmias (ventricular tachycardia or >30 multiform ventricular premature beats per hour) and supraventricular arrhythmias (supraventricular tachycardia or >100 supraventricular premature beats per hour), and long (>9.5 hours) sleep duration, which was estimated from the subjects' diaries and, more precisely, using the analysis of the 24-hour heart rate trends. The objectively measured (from the heart rate trends) sleep duration was a stronger predictor of health outcomes as compared with the self-reported sleep duration.

The second Holter risk score included the ratio of low- to high-frequency power of HRV of less than 1, SDNN index (mean of the standard deviations of all normal-to-normal intervals over all 5-minute segments), and presence of supraventricular and ventricular tachycardias. Regression analyses showed that the Framingham risk score was associated only with the score of diseases ($P < .05$). The first Holter risk score was the best predictor of self-rated health ($P < .001$) and one of the best predictors of grip strength ($P < .01$). The second Holter risk score was the best

[a] Dr Shkolnikova from the Max Planck Institute for Demographic Research (Rostock, Germany) and the Federal Russian Center for Children's Arrhythmia (Moscow, Russia) presented the results of the Moscow Pilot Study, which was conducted by the Max Planck Institute for Demographic Research to assess the value of Holter monitoring in older adults.

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Table 1
Regression analyses of links between 7 health outcomes and 7 risk scores (controlled for age and sex)

Dependent variable	Self-rated health	Mobility limitations	Score of diseases	Right grip strength	Immediate recall	Stress score
Type of regression	OLOGIT	OLS	OLS	OLS	OLS	OLS
Conventional risk score	**0.39 (3.01)****	0.11 (1.17)	0.12 (0.41)	−0.92 (−1.17)	**−0.45 (−2.47)*****	0.86 (1.58)
Framingham risk score	0.07 (1.32)	0.03 (1.06)	**0.18 (2.22)****	0.06 (0.20)	−0.05 (0.91)	0.14 (1.00)
First Holter risk score	**0.53 (3.10)******	0.17 (1.85)*	**0.60 (2.39)****	**−1.48 (−2.67)*****	−0.28 (−1.79)*	0.81 (1.69)*
Second Holter risk score	0.43 (1.45)	**0.54 (2.51)****	**1.34 (2.86)*****	−0.48 (−0.51)	−0.96 (−2.20)**	**2.30 (2.65)*****
First Holter + conventional	**0.42 (3.12)*****	**0.15 (2.23)****	0.31 (1.67)*	**−1.23 (−2.67)*****	**−0.33 (−2.71)*****	**0.89 (2.42)****
AL score	0.00 (0.00)	−0.07 (−1.03)	−0.02 (−0.10)	−0.05 (−0.17)	0.02 (0.19)	−0.09 (−0.35)
First Holter + conventional + AL	0.14 (1.82)*	0.02 (0.41)	0.14 (1.16)	**−1.04 (−3.51)******	−0.05 (−0.70)	0.17 (0.74)

t values are given in parentheses. OLOGIT indicates ordinal logistic; OLS, ordinary least squares.
* $P < .1$.
** $P < .05$.
*** $P < .01$.
**** $P < .001$.

predictor of the score of diseases ($P < .01$) and perceived stress ($P < .01$). Statistically significant associations ($P < .05$) with mobility limitations and immediate recall were also found for this score. For mobility limitations, a combination of the first Holter and the conventional risk scores was significant ($P < .05$). For immediate recall, the conventional risk score or its combination with the first Holter risk score provided highly significant predictions ($P < .01$).

In summary, the 2 Holter risk scores were found to be predictive of health outcomes in the data collected from the 185 older adults. For self-rated health and grip strength, the first Holter score or a combination of the conventional and the first Holter risk scores had predictive power. The second Holter risk score was a better predictor for mobility limitations, score of diseases, and perceived stress, and the 2 Holter risk scores complemented each other. Studies combining characteristics of heart rate with various health assessments would be promising.

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HyperQ: a novel technique for detecting stress-induced ischemia using analysis of the electrocardiographic depolarization phase

E. Toledo[b]

The aims of this study were to test the performance of this technique in consecutive patients undergoing exercise myocardial perfusion imaging (MPI) using stress single-photon emission computed tomography and to compare its performance with conventional electrocardiographic (ECG) analysis using MPI as the gold standard. Exercise MPI was performed in 95 consecutive patients (72 men and 23 women; age, 62 ± 11 years) and was used as the gold standard for ischemia. Patients were eligible if they were willing to provide informed consent, had an interpretable ECG, and were able to walk on the treadmill. Exclusion criteria included cardiac pacemaker placement, atrial fibrillation at the time of testing, complete left or right bundle-branch block, interventricular conduction defect, and ST-segment depression of at least 1 mm at rest before exercise testing. The institutional review board approved the research protocol and the informed consent form.

Conventional exercise ECG recording was combined with high-resolution ECG acquisition, which was digitized and analyzed using a HyperQ system (BSP Ltd, Tel Aviv, Israel). The software extracted the high-frequency components of the QRS complex (HyperQ), classified the HyperQ data from the 12 leads, and discarded those leads that had a very low signal-to-noise ratio. The remaining leads with sufficient signal-to-noise ratio were examined for the presence of reduction in HyperQ intensity. Leads that exhibited relative reduction greater than 40% were considered indicative of ischemia and were visually marked. The HyperQ test was considered positive if at least 2 leads were indicative of ischemia. The system provided a quantitative index of ischemia based on the HyperQ response to exercise. It is important to note that analysis of HyperQ data was computerized, resulting in an automated, objective, and quantitative assessment of the data with no interobserver and intraobserver variability.

ST segments were considered abnormal if there was at least 1 mm of horizontal or downsloping depression 80 milliseconds after the J point for at least 3 consecutive beats in 2 contiguous leads. Stress testing was performed with the use of a treadmill (the Bruce protocol). Each patient was studied under fasting conditions. Patients were asked to discontinue their antianginal medications 24 hours before testing and their β-blocker medications 48 hours before testing. Imaging protocol and image analysis were performed according to an acceptable protocol. Perfusion defects were analyzed visually and semiquantitatively.

The analysis was possible in 85 patients, 33 of whom exhibited MPI ischemia. Stress-induced ischemia was characterized by a reduction in HyperQ intensity (Fig. 1, left column), whereas the normal HyperQ response was characterized by either a constant or an increase in intensity (Fig. 1, right column). Ischemic HyperQ response was found in 25 of the 33 ischemic subjects and in 8 of the 52 nonischemic subjects. Four subjects exhibited ST depression at rest and 17 subjects exhibited inconclusive ST changes. Significant ST changes were detected in 15 of 27 patients with MPI ischemia and in 19 of 50 patients without MPI ischemia.

The HyperQ index of ischemia exhibited higher sensitivity relative to conventional ST analysis (76% vs 59%; $P < .01$), improved specificity (85% vs 57%; $P < .001$), higher positive predictive and negative values (76% vs 49% [$P < .01$] and 85% vs 70% [$P < .05$], respectively), and higher accuracy (81% vs 58%; $P < .001$).

In summary, this study sought to compare the diagnostic value of HyperQ analysis with conventional ECG interpretation in a realistic clinical setting. The acquisition of HyperQ data during exercise MPI allows for direct comparison of the 3 techniques for ischemia detection: HyperQ, conven-

Fig. 1. Left column, An example of the HyperQ response in a patient with ischemia. The upper screen shot shows the heart rate trend throughout the exercise test and the corresponding HyperQ time-intensity curves for each of the 12 leads. Leads that exhibited significant HyperQ reduction are indicated by red curves, whereas those with less-pronounced reduction are indicated by black curves. The values of absolute and relative HyperQ reduction are provided for each lead. The bottom screen shot shows color representations of the HyperQ data for all leads. The x-axis indicates the time along the exercise test, whereas the y-axis indicates the time along the QRS complex. The red color corresponds to high values of the HyperQ signal, whereas the blue color corresponds to low HyperQ values. Right column, An example of the HyperQ response in a patient with normal myocardial perfusion. None of the leads exhibited ischemic HyperQ response, thus suggesting that this patient has no perfusion defect. The color representations show constant HyperQ intensity throughout the exercise test, manifested as a continuous horizontal red stripe.

[b] Dr Toledo from BSP Ltd (Tel Aviv, Israel) discussed a novel high-resolution technique for detecting stress-induced ischemia using analysis of the electrocardiographic depolarization phase and presented results of clinical testings conducted at the Rabin Medical Center Cardiology Department in Petah Tikva, Israel.