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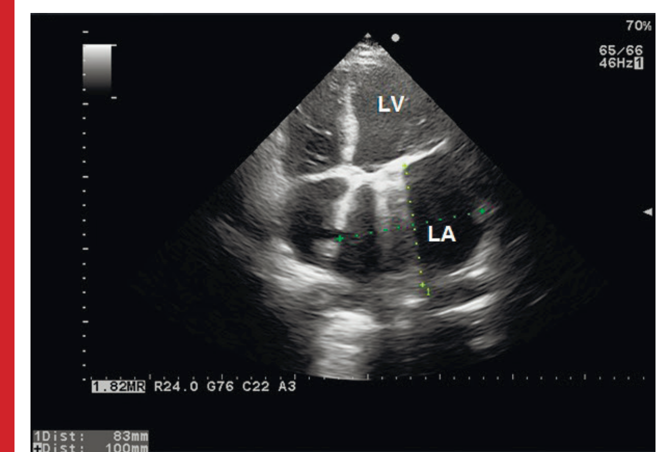

Figure 3. Transthoracic echocardiogram (apical 4-chamber view), showing thedisproportionate size of the left atrium (LA) compared with the left ventricle (LV) andthe other cardiac chambers.

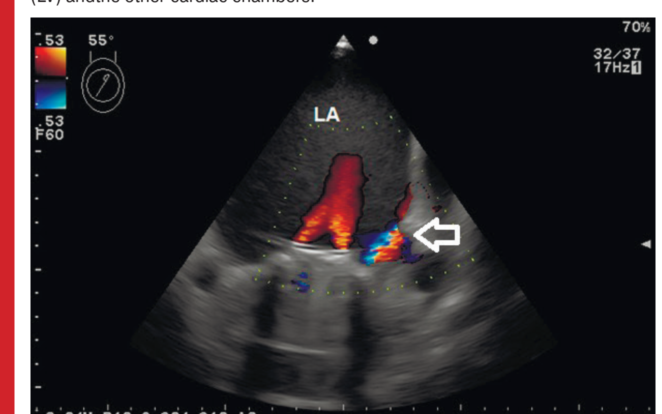

Figure 4. Transesophageal two chamber view demonstrating small mitralparavalvularleak (arrowhead).

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EFFECTIVENESS OF UNIPOLAR RADIOFREQUENCY SURGICAL ABLATION FOR ATRIAL FIBRILLATION

Adriano Meneghini[1], Marcelo Rodrigues Bacci[1], Neif Murad[1], Antonio Carlos Palandri Chagas[1], José Honório Palma[2], Luiz Carlos de Abreu[1], Vitor E. Valenti[1], João Roberto Breda[2]

Aim. To verify the effectiveness of surgical ablation for atrial fibrillation by irrigated unipolar radiofrequency, applied to both atria, for the reversal and maintenance of the sinus rhythm in the short and medium term in patients undergoing concomitant cardiac surgery.

Material and methods. Between February 2008 and March 2012 a total of 35 consecutive patients with persistent and permanent paroxysmal AF underwent surgical tachyarrhythmia ablation by irrigated unipolar radiofrequency applied biatrially with concomitant cardiac surgery. All cases were diagnosed at least 12 months before the procedure and the group consisted of 15 (42,8%) male and 20 female (51,2%) patients, aged 25-78 years (52,23±12,82).

Results. There were 24 (68,5%) patients with rheumatic mitral valve disease with 25,8% with degenerative disease. The left atrial diameter measured by transthoracic echocardiography ranged from 44 to 70 millimeters (mm) (55,31±18,10).There were two hospital deaths in this series. Upon discharge, we observed the following rhythms and percentages: 24 (68,5%) — sinus rhythm, 7 (20%) — AF and 4 (11,5%) — junctional rhythm. At medium term follow-up we obtained the following results: 11 (73,3%) — sinus rhythm, 2 (13,35%) — junctional rhythm and 2 (13,35%) — AF.

Conclusion. Surgical ablation by irrigated unipolar radiofrequency applied to both atria is effective in the reversal and maintenance of sinus rhythm during short and medium term follow-up.

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Key words: atrial fibrillation, unipolar radiofrequency, heart failure.

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ЭФФЕКТИВНОСТЬ ОДНОПОЛЯРНОЙ РАДИОЧАСТОТНОЙ ХИРУРГИЧЕСКОЙ АБЛАЦИИ ПРИ ФИБРИЛЛЯЦИИ ПРЕДСЕРДИЙ

Adriano Meneghini[1], Marcelo Rodrigues Bacci[1], Neif Murad[1], Antonio Carlos Palandri Chagas[1], José Honório Palma[2], Luiz Carlos de Abreu[1], Vitor E. Valenti[1], João Roberto Breda[2]

Цель. Проверить эффективность хирургической абляции при фибрилляции предсердий однополярным методом, применяемым для обоих предсердий, для реверсирования и поддержания синусового ритма в краткосрочной и среднесрочной перспективе у пациентов, подвергнутых сочетанной сердечно-сосудистой хирургии.

Материал и методы. В период с февраля 2008г и в март 2012 г всего 35 пациентов с персистирующей и постоянной ФП были подвергнуты хирургической аблации тахиаритмий однополярным методом, примененным билатерально с сопутствующей сердечно-сосудистой хирургией. Все случаи были диагностированы по крайней мере 12 месяцев перед процедурой, в группе было 15 (42,8%) мужчин и 20 женщин (51,2%) больных, в возрасте 25-78 лет (52,23±12,82).

Результаты. У 24 (68,5%) больных был диагностирован ревматический митральный порок сердца, из которых у 25,8% — с дегенеративным заболеванием. Диаметр левого ушка предсердия, измеренный трансторакальной эхокардиографии колебался от 44 до 70 миллиметров (мм) (55,31±18,10).Были констатированы два смертельных случая в этой группе. После выписки мы наблюдали следующие ритмы и проценты: 24 (68,5%) — синусовый ритм, 7 (20%) — ФП и 4 (11,5%) — сочетанный ритм. В среднесрочной перспективе последующих получены следующие результаты: 11 (73,3%) — синусовый ритм, 2 (13,35%) — сочетанный ритм и 2 (13,35%) — ФП.

Заключение. Хирургическая радиочастотная абляция однополярным методом применяется для обоих предсердий и является эффективным для восстановления и поддержания синусового ритма при коротких и средних сроках наблюдения.

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Ключевые слова: фибрилляция предсердий, радиочастотная униполярный, сердечная недостаточность.

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Atrial fibrillation (AF), whose prevalence increases with age, represents the most common sustained disturbance of cardiac rhythmin the presence or absence of structural heart diseases. Its occurrence is associated with not only increased morbidity and mortality rates, which are related to hemodynamic deterioration and complications owing to the use of anticoagulants, but also with increased hospital costs [1].

The Cox-Maze III operation represents the most effective method for treatment of AF. However, despite the fact it is considered the gold standard of therapy; its effectiveness is inversely proportional to its applicability [2]. Thus, several alternative energy sources (cryoablation, microwave, radiofrequency) have been used in an attempt to create a lesion similar to that obtained by the "cut and suture" technique [3-5].

The use of radiofrequency in surgical treatments of AF has been reported with good results and few complications in several studies. This radiofrequency, either uni- or bipolar, was initially used in the electrophysiology laboratory. It was the first alternative energy source applied in such treatments and has been widely tested in recent years [6, 7]. The irrigated unipolar device produces a linear lesion of the tissue when the point-to-point power source is applied.

In our method, unipolar radiofrequency is the most often widely used energy source in the surgical treatment of AF with structural heart disease. However, some authors suggest that the effectiveness of this unipolar source is lower when compared with other methods in the restoration of normal sinus rhythm [8, 9].Therefore, we adopt the AF ablation by irrigated unipolar radiofrequency, biatrially applied, for the treatment of AF (paroxysmal, persistent or permanent), with concomitant cardiac surgery [10].

The aim of this study is to verify the effectiveness of surgical ablation foratrial fibrillation by irrigated unipolar radiofrequency, applied to both atria, for the reversal and maintenance of sinus rhythm in the short and medium term in patients undergoing concomitant cardiac surgery.

Material and methods

Patients and Study Design. A total of 35 consecutive patients with paroxysmal, persistent and permanent AF, diagnosed 12 months before the surgical procedure, were screened between February 2008 and March 2012.

Patients had indication to surgery when signs of cardiac congestion were apparent. About 51.4% of the patients were in New York Heart Association (NYHA) Heart Failure functional class (FC) II and 48.6% in class III. The follow-up period after surgery ranged from 1 to 60 months (mean of 9±4).

They underwent surgical ablation of tachyarrhythmia by irrigated unipolar radiofrequency applied biatrially, with concomitant cardiac surgery. The study protocol was approved by the local ethics and research committee of Faculdade de Medicina do ABC (ABC Medical School) and the Federal University of São Paulo (UNIFESP). Patients were included after signing a term of informed consent.

Left ventricular ejection fraction (LVEF) below 35%,the presence of infectious endocarditis, contra-indication to anticoagulant therapy or unstable arrhythmia defined as non-controlled heart rate were considered exclusion criteria.

Surgical Technique. The operation began with the performance of hemodynamic monitoring by measuring the mean arterial pressure, the central venous pressure and urine output. In addition, respiratory rate was verified by pulse oximetry.

The surgery was carried out in the usual way, with median sternotomy as access, cannulation of the aorta and the superior and inferior vena cava after intravenous administration of heparin (400 IU/kg) and moderate hypothermia at 32°C

The myocardial protection method used was hypothermic antegrade blood cardioplegia (approximately 18°C) with added potassium (15 mEq/L) in induction. In the subsequent doses, at intervals of 15 minutes, perfused blood was administered at 32°C without adding any other substance.

The mitral valve approach was made transseptally, followed by valve repair or replacement (using a biological or metal prosthesis).

After the valve procedure, patients underwent surgical treatment for atrial fibrillation, with excision of the right and left atrial appendage (RAA and LAA) and an incision of 4 centimeters (cm) from the middle portion of the RAA removed towards the superior vena cava orifice. Thereafter, irrigated radiofrequency was applied in the endocardium of both atria following the procedures described in a previous publication. The Medtronic Cardioblate® Unipolar Surgical Ablation Pen was the instrument of choice (Medtronic Inc., Minneapolis, MN)[10].

At the end of the operation, patients in normothermia were taken to the postoperative unit, where electrocardiography was carried out every 12 hours and they were clinically monitored throughout their stay. They were then discharged, and one month after the surgery follow-up was done with ECG, echocardiography and 24-hour Holter monitoring. During the course of treatment all subjects were accompanied by a single member of the surgical team, who filled out a protocol form for the sake of pre- and postoperative data comparison.

Post-surgery drug protocol. The treatment protocol after the application of irrigated radiofrequency initially involved the use of amiodarone (100-400 mg daily) in order to control atrioventricular nodal conduction and for atrial stabilization before discharge. It was prescribed individually, taking into account the potential side effects of this medication.

Moreover, we administered oral anticoagulants to maintain INR (International Normalized Ratio) between 2.0 and 3.0. In the event of reversal and maintenance of sinus rhythm, anticoagulant therapy was maintained for at least four weeks. On the other hand, whenever there was no reversion of the sinus rhythm, two attempts at electrical cardioversion (ECV) were scheduled, with an interval of 4 to 6 weeks between both attempts. In the case of failure, the use of oral anticoagulants and drugs was maintained, with referral of the patient for electrophysiological study (after gradual discontinuation of amiodarone).

Results

In Table 1 the clinical and demographical data of the patients can be observed. The group consisted of 15 (42,8%) male and 20 female (51,2%) patients. The mean age for men was 52,23±12,82 years. In 24 (68,5%) patients the mitral valve disease was rheumatic, in 9 (25,8%) it was degenerative, 1 (2,85%) was ischemic and 1 (2,85%) had mitral stenosis after repair with a ring. The mean left atrial diameter measured by transthoracic echocardiography was 55,31±18,10 mm.

There were two hospital deaths in this series: one patient who went into cardiogenic arrest and another from sepsis due to pulmonary infection.

In Table 2 the surgical data is shown. Mitral repair was performed in 6 cases (17,1%), a biological prosthesis was implanted in 19 cases (54.2%) and a metallic prosthesis in 10 cases (28,7%). The mean CPB time was 128±26,32 minutes and the anoxia time was 88,60±17,30 minutes. The average time for performing ablation was 8,72±1,91 minutes.

Table 3 shows the data of the immediate postoperative period, with 26 (74,3%) patients in sinus rhythm, 4 (11,4%) in AF, 4 (11,4%) in junctional rhythm and 1 (2,9%) with total atrioventricular blockage (TAVB) requiring artificial cardiac stimulation with a temporary pacemaker.

During the postoperative follow-up until hospital discharge, 3 patients showed AF, including the case that reverted to TAVB. Thus, at discharge, we observed the following rhythms and percentages: 24 (68,5%) — sinus rhythm, 7 (20%) — AF, and 4 (11,5%) — junctional rhythm.

Also during postoperative follow-up 50% of the AF patients had reversion to sinus rhythm after electrical cardioversion. At the mean follow-up time we obtained the following results: 11 patients (73,3%) with sinus rhythm, 2 (13,35%) with junctional rhythm and 2 (13,35%) with AF. Among the patients who remained in AF, left atrial diameters were greater than 65 mm.

Table 1

Preoperative clinical and demographic data

Variables	Frequency
Gender	
– Female – Male	57,2 42,8
Age (years)	52,23±12,82
NYHA – II – III	 51,4 48,6
History of thromboembolism	16,7
Left Atrium Diameter (mm)	55,31±18,10

Results expressed as percentage for categorical variables and mean and standard deviation for continuous variables.

Table 2

Surgical data

Procedure	Unipolar radiofrequency
Mitral valve replacement Mitral valve repair	82,9 17,1
Anoxia time (min)	88,60±17,30
Perfusiontime (min)	128±26,32
Ablationtime (min)	8,72±1,9

Results expressed as percentages for categorical data and mean and standard deviation for continuous variables.

Table 3

Post-operative (PO) Unipolar radiofrequency patients data and follow-up

Rhythm	PO	Discharged	PO follow-up
Sinus rhythm	74,3	68,5	73,3
AF	11,4	20	13,35
Junctional rhythm	11,4	11,5	13,35
Pacemaker	2,9	-	-

Results expressed as percentages.

Discussion

In experimental studies, achieving transmurality with unipolar radiofrequency requires prolonged application time (over two minutes). During the mitral valve surgery it was observed that after two minutes of unipolar endocardial ablation only 20% of the lesions were transmural [11]. This finding plays an important role in the success of the procedure once transmurality is a fundamental requirement in association with the ablation lines employed. Thus, due to the difficulty in confirming whether the lesion produced by the application of unipolar radiofrequency was actually transmural, it is advisable to apply energy to the endocardium slowly (preferably between 8 and 10 minutes of ablation or at a rate of 10 to 15 cm/second).

In 2008 Myrdko et al published a prospective study involving 100 patients with permanent AF and mitral valve disease, with surgical indication for replacement or valvuloplasty. The patients had similar demographic and clinical characteristics and were divided into two groups: one for isolated mitral valve replacement and the other for concomitant treatment of arrhythmia with unipolar radiofrequency. At hospital discharge 56% of the patients undergoing unipolar ablation were in normal sinus rhythm, compared with only 22% of the isolated mitral group. After a one-year follow-up, the percentage of patients in sinus rhythm was 54 versus 16% (unipolar ablation group and control respectively). Both groups received pharmacological treatment with amiodarone for three months, followed by electrical cardioversion in the event of persistence of the tachyarrhythmia. The main factors identified by the failure of the unipolar ablation in this study were the left atrial diameter over 60 millimeters (mm) and the presence of severe left ventricular dysfunction [12].

Johansson et al showed similar results in patients undergoing coronary artery bypass grafting and unipolar ablation in a longer follow-up period (32±11 months) and with assessments at 3 and 6 months post-operatively. The success rate obtained was of 62% versus 33% (ablation versus control group). Furthermore, the authors demonstrated improved quality of life after restoration of sinus rhythm [13].

In this consecutive series we observed results similar to those previously reported in the literature, with mean follow-up times of nine months. Just like other studies, the rhythm monitoring was performed essentially by the surface electrocardiogram and 24-hour Holter recording, which obviously may limit the diagnosis of asymptomatic events. For the next patients, continuous monitoring of the cardiac rhythm by ECG telemetry is suggested in order to solve this issue.

A different approach to analyze the effect of radiofrequency ablation for AF was published by Zangrillo et al, evaluating the changes in troponin levels in 142 patients. The researchers found no significant change in this marker when comparing unipolar ablation with isolated mitral valve surgery groups (p=0,7), concluding that the method is safe with little interference in cardiac structure [14].

Despite the advances in understanding the mechanisms that generate AF, surgical treatment should ideally be individualized according to each case. The flaw in the application of unipolar radiofrequency can be directly related to either ablation lines or the fact that the generating focus of the arrhythmia is not in the left atrium. The performance of the bi-atrial technique corroborates the best results. Between 9 and 19% of cases have the origin of arrhythmia in the right atrium, and such cases additionally benefit from the application of bi-atrial lines. Another important factor is the time of application of the endocardial unipolar radiofrequency because, unlike bipolar devices, the transmurality of the lesion is more difficult to obtain. We conclude that standardization of the surgical technique in the application of unipolar radiofrequency is directly related to higher success rates [15-17].

In 2012, Chen Y et al, reviewing the effectiveness of unipolar radiofrequency, observed success rates in restoring sinus rhythm ranging from 54 to 83% in a mean period of 12 months. The procedure is safe and effective, especially in patients with paroxysmal or persistent AF, young individuals with a left atrial diameter less than 60 mm, regardless of the type of heart surgery performed [12, 13, 18, 19]. It is noteworthy that all these works lack a monitor capable of identifying asymptomatic episodes of tachyarrhythmia, since in most cases the follow-up is done with surface electrocardiograms and 24-hour Holter monitoring.

Thus, the irrigated unipolar radiofrequency technique for treatment of atrial fibrillation can achieve a success rate of 80% in late follow-up work. This success rate, however, is often not obtained before 3 to 6 months post-operatively. Therefore, patients that remain in AF before this time should not be considered as a failure of the procedure.

Most patients undergoing this ablation technique leave the operating room in sinus rhythm. However, about 70% of the cases have episodes of AF in the immediate postoperative period. The main factors involved are the likely neurohormonal imbalance and the inflammation of the pericardium [20-22]. The expected result is that about 50% of patients undergoing irrigated radiofrequency ablation receive hospital discharge in sinus rhythm whereas the remaining cases will probably be in the process of "reverse atrial remodeling", which will facilitate possible spontaneous or medical (pharmacological or electrical) reversion to the normal rhythm during the post-operative follow-up.

In conclusion, the results of this study suggest that surgical ablation by irrigated unipolar radiofrequency for atrial fibrillation, applied to both atria, is effective in the reversal and maintenance of sinus rhythm during short and medium term follow-up.

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A COMPARISON OF PSYCHOLOGICAL STATUS OF PATIENTS PRE AND POST CORONARY ARTERY BYPASS GRAFT SURGERY

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Aim. Coronary artery bypass grafting (CABG) is a procedure used to help improve and save the lives of thousands of coronary artery diseases patients every year. Measuring psychological status of patients, significantly contributes to understanding patient perceptions of outcomes attributable to this surgery. The aim of this study was comparison of psychological status s of patients before and 3 months after CABG.

Material and methods. In this cross sectional study a total of 120 consecutive patients who submitted to CABG were examined a few days before and 3 months after CABG at the Ekbatan hospital in Hamadan/Iran in 2012. The SCL-90 Questionnaire was used to measure psychological dimensions pre and post CABG. Data analysis was performed using SPSS version 18. Paired t-tests were used to compare pre-operative and postoperative SCL-90 scores.

Results. Significant differences were found between before and after CABG in patients' scores of somatization, obsession-compulsion, interpersonal sensitivity, depression and Anxiety subscales (p<0,001) of the SCL-90 Questionnaire.

Conclusion. Preoperative assessment could identify patients at risk for clinical levels of postoperative psychological problems. Detection of psychological symptoms during the pre- operative evaluation was essential for diagnostic orientation and, if needed, counseling and therapeutic interventions could be instituted.

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Key words: coronary artery bypass, psychological status, anxiety, depression, somatization.

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СРАВНЕНИЕ ПСИХОЛОГИЧЕСКОГО СТАТУСА ПАЦИЕНТОВ ДО И ПОСЛЕ КОРОНАРНОГО ШУНТИРОВАНИЯ

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Цель. Аортокоронарное шунтирование (АКШ) — это вмешательство, используемое чтобы помочь улучшить и ежегодно сохранять жизни тысяч пациентов с ишемической болезнью сердца. Измерение психологического статуса пациентов значительно способствует пониманию восприятия пациентами результатов лечения. Целью данного исследования было сравнение психологического статуса больных до операции и спустя 3 месяца после АКШ.

Материал и методы. В это кросс секционное исследование вошли, в общей сложности, 120 последовательных пациентов, которые были обследованы за несколько дней до и 3 месяцев после выполнения АКШ в больнице Ekbatan в Хамадане (Иран) в 2012г. Использовался вопросник SCL-90 для измерения психологических измерений до и после АКШ. Анализ данных проводили с использованием пакета программ SPSS версия 18. В паре т-тесты были использованы для сравнения предоперационного и послеоперационного количества баллов вопросника SCL-90.

Результаты. Значимые различия были обнаружены между значениями баллов до и после АКШ у пациентов по значениям: соматизация, навязчивость-принуждение, межличностная чувствительность, депрессия и тревожность опросника SCL-90 (p<0,001).

Заключение. Предоперационная оценка может выявить пациентов с риском клинических уровней послеоперационных психологических проблем. Можно сделать заключение, что выявление психологических симптомов во время предоперационной оценки имеет большое значение для диагностической ориентации и, при необходимости, консультирования и терапевтических вмешательств.

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Ключевые слова: аортокоронарное шунтирование, психологическое состояние, тревожность, депрессия, соматизация.

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Coronary artery disease (CAD) and stroke are the first and second leading causes of death in middle-income countries [1]. Iran possibly has a higher burden than other countries in this region [2]. Coronary artery disease (CAD) is a leading cause of mortality, morbidity and disability with high healthcare costs in Iran. It accounts for nearly 50 percent of all deaths per year [3]. Coronary artery bypass graft (CABG) surgery is one of the CAD treatments [1]. And also, it is one of the most commonly performed surgical procedures worldwide, intended to treat ischemic heart disease and alleviate angina pectoris [4]. In Iran, 60% of the total open heart surgery is coronary artery bypass surgery [5]. The benefits of coronary artery bypass graft surgery with respect to survival, improved ventricular function, freedom from angina in coronary artery disease (CAD) populations are well established [1], besides reducing the likelihood of future heart attacks and prolonging life-expectancy. Another goal is to improve health-related quality of life and psychological well-being. After successful surgery the majority of patients can have an improved everyday life, with increased performance in physical, social and sexual functioning and decreased levels of depression, anxiety, fatigue and sleep [6].

The negative emotional reactions are frequent among CAD patients [7, 8]. And also, CABG surgery is a major incident with a main psychological and emotional impact on patients and their families [9]. Numerous prospective cohort studies focus on the short and long term outcome of CABG surgery. CABG is a physical and psychological stress and the surgery is as a life- threatening incident for patients who are along with adapting problems and hospital schedules, they feel suffering and lack of control and hospitalization separates them from their relatives, friends and everyday life situation [10,11].

In a prospective study, 18,5% of MI patients were suffering from a depressive disorder, but depressive symptoms have been reported in as many as 47% of CAD patients [12]. Whooley (2006) reported that depressiveness is presented in 20% of CAD outpatients, and as 50% of patients recently hospitalized for CABG surgery [13]. And also, evidence suggests that between 30% and 40% of CABG surgery patients experience a form of depression (i.e., major, minor or dysthymia) immediately leading up to and after surgery [11, 14]. But other studies have identified positive changes in patient's physical health and mental health after CABG [15, 16]. Anxiety has similar consequences of depression in CAD patients and the prevalence of it is reported to be higher in these patients than in the general population [7, 8]. The role of anxiety as a prognostic factor in the development of adverse cardiac events among patients with CAD is not well understood [17]. anxiety has also been suggested as a potential predictor of negative outcome on post-CABG recovery, but results are inconsistent and the effects of anxiety are sometimes difficult to differentiate from the effects of depression [18].

Recent study has suggested that early identification of depression and anxiety initiating the treatment at an early stage is important in the prevention of new cardiac events after CABG surgery and to enhance the patient's quality of life [11]. A survey on 796 cardiovascular physicians determined 71,2% of respondents asked fewer than half of their patients with CAD about depression [19].

Systematic reviews have also identified depression as a predisposing factor to increase the risk for delirium among cardiac surgery populations [20]. In the hospitalized patient, a delirious state may manifest itself as a fluctuating course of disorientation to time, place and persons, perceptual disturbances and hallucinations. Delirium is the most common psychiatric disorder observed upon admission to healthcare settings [21]. A prognostic study on 158 CABG patients showed that even when diagnostic criteria for delirium is modified to reduce bias from overlapping delirium-depression symptoms, pre-operative major depression remained associated with incident delirium after CABG surgery [22].

It is believed nursing is a profession that provides comprehensive caring based on organized system and using nursing science. Nurses evaluate and take care of a patient along with health care team on the base of their knowledge, integrated presence planning, programming and management. Impact the illness and invasive producers on health is understandable by a patient's perspective, therefore, patients' perception of health and stressors is crucial for meaningful nursing and care programs [23]. Despite the importance of identifying patient needs and psychological stressors in developing strategies of coping and effectively managing psychological aspects by health professionals, few studies have been done in this connection. When the psychological aspects are identified by health professionals, they can deal with the stressors affecting the patient by manipulating the environment and provide the appropriate care. Therefore, this study was performed to determine patients' psychological status before and 3 months after coronary artery bypass surgery.

Materials and Methods

Study Population and Protocol: This is a cross — sectional study. A non-probability convenience sample of 120 women and man of various ages was obtained from the Ekbatan hospital in Hamadan/Iran and then followed three months after discharge from the hospital with the approval of the appropriate institution to assess the patients. The inclusion criteria included patients who: (a) were scheduled for an elective CABG, (b) had no prior CABG surgery, (c) had signed an informed consent form and (d) were able to read and write Persian. Exclusion criteria included emergency CABGs and the presence of any other major medical condition, such as neurological problems, or psychotic disorders.

Permission to conduct the study was provided by the local ethic committees. Patients receive detailed written information about the study. Written consent is obtained from the subjects. Anonymity of the data is ensured by using envelopes for the completed questionnaires. Patient data solely are encoded with individual anonymous key codes. At the time of informed consent the patient was asked to provide their address and phone number for contact postoperatively. While the patients were in the hospital awaiting an elective CABG in the hospital, data collection took place in a private room with no extraneous external distractions and confidentiality was ensured when completing the questionnaire. Psychological status assessed by the Symptom Checklist (SCL-90) pre-surgery. The postoperative questionnaires were mailed to the participants with a self-addressed stamped envelope there were no identifying information or markers on the packets and they were double enveloped to ensure confidentiality.

Table 1

Result of SCL- 90 Scores of Patients with CABG

Subscale	Pre CABGs, Mean±SD	Post CABGs, Mean±SD	T	P
Somatization	1,56±0,53	1,37±0,48	8,29	<0,001
Obsessive-compulsive	1,71±0,68	1,62±0,54	3,16	<0,001
Interpersonal sensitivity	1,36±0,64	1,15±0,61	3,19	<0,001
Depression	1,52±0,59	1,35±0,59	0,87	<0,001
Anxiety	1,46±0,54	1,29±0,43	1,91	<0,001
Hostility	1,61±0,66	1,59±0,55	5,89	0,06
Phobic anxiety	1,24±0,41	1,23±0,41	0,82	0,08
Paranoid ideation	1,45±0,58	1,43±0,57	0,77	0,4
Psychoticism	1,44±0,51	1,39±0,42	7,59	0,06

Measurement tools. The instrument chosen for this study was Persian version of "The Symptom Checklist 90". The SCL-90 consists of 90-item self-report symptoms inventory that designed primarily to reflect the psychological symptom patterns of psychiatric and medical patients. It is a measure of current, point-in-time psychological symptom status, not a measure of personality. Each item of the questionnaire is rated by the patient on a five-point scale of distress from 0 (none) to 4 (extreme). The SCL-90 consists of the following nine primary symptom dimensions: Somatization (This dimension reflects distress arising from bodily perceptions.

Complaints focused on cardiovascular, gastrointestinal, respiratory, and other systems with autonomic mediation are included), Obsessive-compulsive (The focus is on thoughts, impulses, and actions that are experienced as irresistible by the individual but are of an ego-alien or unwanted nature), Interpersonal sensitivity (This dimension focuses on feelings of personal inadequacy and inferiority in comparisons with others. Self-deprecation, uneasiness, and discomfort during interpersonal interactions are included here), Depression (Symptoms of dysphoric mood and affect as well as signs of withdrawal of life interest, lack of motivation, and loss of vital energy are represented. Feelings of hopelessness, thoughts of suicide, and cognitive and somatic correlates of depression are included), Anxiety (Nervousness, tension, and trembling as well as feelings of terror and panic are included. Some somatic correlates of anxiety are also included here), Hostility (Thoughts, feelings, or actions characteristic of the negative affect state of anger are reflected here. Qualities such as aggression, irritability, rage, and resentment are included), Phobic anxiety (Phobic anxiety is defined as a persistent fear response to a specific person, place, object, or situation which is characterized as being irrational and disproportionate to the stimulus), Paranoid ideation (Projective thinking, hostility, suspiciousness, grandiosity, centrality, fear of loss of autonomy, and delusions are viewed as primary reflections of this disorder) and Psychoticism (The scale provides a continuum from mild interpersonal alienation to dramatic evidence of psychosis. Items include withdrawal, isolation, and schizoid lifestyle as well as first-rank schizophrenia symptoms such as hallucinations and thought-broadcasting) [24].

Statistical analysis. Data were analyzed by using SPSS software version 13,0 (SPSS, Chicago, IL, USA) and presented as mean standard deviation. The normal distribution of the variables was analyzed with the Kolmogorov-smironov test. The difference between the two groups was tested via Independent Student's t-tests for normally distributed variables and Mann– Whitney U test was used for non-parametrically distributed variables. The difference between the categorical variables was determined by the X2-test. Significance was defined as P< 0,05.

Results

The majority of the subjects (69,4%) was male and ranged in age from 40 to 76 years. The overall mean age was 58±4 years. 83% of the subjects were married, 13,2% widowed and 6% single. When questioned about their health-related habits, 31,4% of the subjects reported that they still smoked and 65% had a history of cigarette smoking, 85% did not exercise regularly. Data analyses indicated that 46,0% of the patients before and 38,7% after CABG surgery were highly anxious. 39,8% of the patients were depressed two days before and 21,8% after CABG surgery, obsessive-compulsive was 23,3% before and 18,5% after surgery. Interpersonal sensitivity was 38,1% before and decreased to 21% after surgery. Somatization was 34,1% before and 28,6 after surgery. Hostility Phobic was 18,3% before and 16,9% after surgery. Paranoid ideation was 9,8% before and 10,6% after surgery. Psychoticism was 7,6% before and 6.8% after surgery. Therefore three months after CABG surgery, there were improvements in all nine primary symptoms of patients' psychological status.

There were significant differences in somatization (p<0,001), obsessive-compulsive (p<0.001), depression (p<0,001), anxiety (p<0,001), and interpersonal sensitivity (p<0.001) between pre- and post- CABG surgery, but no significant differences were observed for other subscales of SCL-90. The results showed that a larger proportion of

Table 2

The relationships between the scores of SCL-90 and Sex in patients after CABG

Subscale	Female, Mean±SD	Male, Mean±SD	T	P
Somatization	1,53±0,55	1,49±0,51	2,72	<0,001
Obsessive-compulsive	1,76±0,73	1,60±0,58	2,33	<0,001
Interpersonal sensitivity	1,61±0,67	1,49±0,58	2,44	<0,001
Depression	1,57±0,64	1,45±0,49	2,84	<0,001
Anxiety	1,49±0,59	1,16±0,44	1,91	<0,002
Hostility	1,63±0,68	1,55±0,61	1,21	0,2
Phobic anxiety	1,26±0,44	1,21±0,37	2,57	0,08
Paranoid ideation	1,45±0,64	1,33±0,47	3,32	<0,001
Psychoticism	1,51±0,56	1,368±0,43	1,18	0,2

cases had psychological symptoms than 3-months after coronary artery bypass. The detailed results are shown in Table 1.

The patients were divided into 4 age groups (<40; 40-49; 50-59; and ≥60), in order to investigation the statistical influence of age groups on psychological status. ANOVA demonstrated that there were no significant differences between patients' psychological status based on age. When participants were analyzed by gender, men had a poorer psychological status than women, especially in somatization (p<0,001), obsessive-compulsive (p<0,001), interpersonal sensitivity (p<0,001), depression (p<0,001) and anxiety (p<0,001), ideation the results are shown in Table 2.

Discussion

An overall favorable change in terms of psychological parameters was observed between the pre-operative measurement and the three months post-operative measurement. Three months of coronary artery bypass surgery, symptom somatization, obsessive-compulsive, depression, anxiety, interpersonal sensitivity, Hostility, Phobic, Paranoid ideation and Psychoticism were decreased than before it, but there was not totally unconcerned and carefree. It was the same of other study results. The study showed that. however after successful surgery, the majority of patients can have an improved everyday life, with increased performance in physical, social and sexual functioning and decreased levels of depression, anxiety, fatigue and sleep, but an unexpectedly great number of them display only minor recovery in the field of psychological functioning or they do not show it at all [22].

Several authors have analyzed the association between CABG and psychological disorders such as anxiety and depression. The results of those like the present. The present study showed that there were significant changes from preoperative anxiety and depression statue level to postoperative levels [25, 26]. Rymaszewska et al. showed that 55% of the patients pre-operation, 34% shortly after the surgery and 32% of them after 3 months had clinically relevant high level of anxiety [27].Furthermore, In a review of literature study that anxiety was examined before and after CABG, the results showed ~~of~~ that from 142 consecutive patients undergoing CABG, 34,7% were clinically anxious before their operation while 24,7% were anxious after that [28]. In study of Everard et al. the result was also shown that anxiety scores of patients undergoing CABGs was significant changed between before and after the 6-month follow–up [29]. Also Esmaeeli et al. reported significant positive association between pre and postoperative statue of anxiety and pre and post-operative mental health of patients [25]. The decline in anxiety scores from pre- to post- CABGs points to the fact that patients are under psychic stress before CABG surgery [30]. But decline in postoperative anxiety was may reflected, lessening of cardiac disease symptoms, improving activity and returning to approximately normal life.

In the study of Rymaszewska and et al, thirty-two percent of patients before the CABG surgery, 28% immediately after that and 26% at follow-up were depressed [27]. Mahoney et al. reported that prevalence of depression before and also after CABGs was about 20–25%. They claimed that presence of elevated level of depressive symptoms significantly increased overall risk of major cardiac events following cardiac surgery [31].

The other studies with same results of present study, also revealed that there were occurred the reduction in psychological symptoms from preoperative to early postoperative or after 3 and 6- month -follow up [32, 33]. When patients are confronted with the news that they have to undergo CABGs as part of their treatment for coronary artery disease, they may experience great psychological distress. Towell and Nel (2010) state that patients confronted with a life- threatening disease experience intense emotions such as depression, aggression, anxiety, frustration and fear which can cause them to behave irrationally. These emotions can also activate the stress response [33]. There is no doubt that, the aim of CABG surgery should not be limited to improving the cardiac condition. It should also intend to improve the psychological well-being of cardiac patients [30]. Conversely in some other researches, there were conflicting results. Such as in a review of recent literature, Gallagher et al. reported that anxiety level did not change from before to after surgery and remaining low to moderate level [34]. Furthermore Gallo et al. had shown significant incidence of anxiety in patients undergoing CABGs before and also after that [35].

Many studies conducted over the last 10 years had documented that the prevalence of depression and anxiety in pre and post CABGs, but little has been discussed on other psychological aspects. In spite of those, the focus of present study was revealed all numerous psychological statue symptoms. According to results of the present study three months after CABGs, the mean of Somatization, Obsessive-compulsive and Interpersonal sensitivity scores were decreased from before it.

Poor psychological adjustment following surgery can increase the likelihood of new coronary events, further hospitalizations and even death. According to the study of Cser p et al 30% of patients had reduced health related quality of life without being clinically anxious or depressed. They were existing fear of activity, fear of excitement, and give up enjoyed hobbies/activities. The author based on evidence suggested that self-perceived health related quality of life, depressive symptoms and anxiety together influence the short and long term recovery following coronary bypass surgery [36]. The results of present study also were showed a less favorable impact of after CABGs in women than men. Women showed higher rates of psychological problems than men. Previous literature on sex differences in emotional outcomes after CABG surgery has yielded same results. A number of reports have described more symptoms and poorer functioning in women than men at various times after CABG surgery, from 3 months to 5 years after CABG surgery [37-38]. In contrast, other studies showed no significant sex differences in symptoms and functional outcomes during the first year after CABG surgery [39, 40]. Additional investigation reported more adverse outcomes among women in some dimensions of quality of. These conflicting results may be explained in part by differences in methodology. Many reports like present study were also based on convenience samples that may have been too selective to provide meaningful information. In addition, many studies, both positive and negative, did not take into account preoperative differences in health status between the sexes [40].

Conclusion

Monitoring and evaluation of psychological symptoms before CABG surgery could reduce the apprehension and emotional tension experienced by CAD patients after CABG surgery, might prevent adverse psychological effects on healthy recovery, facilitating postoperative recovery and thus reducing the cost of care. Detection of psychological symptoms during the pre- and post- operative evaluation is essential for diagnostic orientation and, if needed, pharmacological or psychotherapeutic interventions can be instituted.

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GEOMETRIC AND LINEAR INDICES OF HEART RATE VARIABILITY DURING AN EXERCISE WITH FLEXIBLE POLE

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Aim. Evaluate the acute effects of a standardized exercise with flexible pole on cardiac autonomic regulation.

Material and methods. We evaluated 23 women between 18 and 25 years old and heart rate variability (HRV) was analyzed in the time (SDNN, RMSSD and pNN50), frequency domain (HF, LF and LF/HF ratio) and geometric analysis (RRTri, TINN, SD1, SD2 and SD1/SD2). The subjects remained at rest for 10 minutes. After the rest period, the volunteers performed the exercises with the flexible poles. Immediately after the exercise protocol, the volunteers remained seated at rest for 60 minutes and HRV were analyzed.

Results. We observed no significant changes in the time domain and frequency domain indices of HRV between before and after single bout of exercise with flexible pole.

Conclusion. A single bout of exercise with flexible pole did not induce significant change in geometric and linear indices of HRV.

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Key words: cardiovascular system, autonomic nervous system, exercise therapy.

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HRV — heart rate variability, DAP — diastolic arterial pressure, SAP — systolic arterial pressure, IPAQ — International Physical Activity Questionnaire, BMI — body mass index, HR — heart rate, SDNN — standard deviation of normal-to-normal R-R intervals, pNN50 — percentage of adjacent RR intervals with a difference of duration greater than 50ms, RMSSD — root-mean square of differences between adjacent normal RR intervals in a time interval, LF — low frequency, VLF — very low frequency, HF — high frequency, LF/HF — low frequency/high frequency ratio.

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ГЕОМЕТРИЧЕСКИЕ И ЛИНЕЙНЫЕ ПОКАЗАТЕЛИ ВАРИАБЕЛЬНОСТИ СЕРДЕЧНОГО РИТМА ВО ВРЕМЯ УПРАЖНЕНИЙ С ГИБКИМ ШЕСТОМ

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Цель. Оценка острого воздействия стандартизированного упражнения с гибким шестом на кардиальную вегетативную регуляцию.

Материал и методы. Мы оценивали 23 женщин в возрасте от 18 до 25 лет и анализировали вариабельность их сердечного ритма (ВСР) во временной области (SDNN, RMSSD и pNN50), в частотной области (соотношение HF, LF и LF/HF) и проводили геометрический анализ (RRTri, TINN, SD1, SD2 и SD1/SD2). Испытуемые оставались в покое в течение 10 минут. После периода отдыха, добровольцы выполняли упражнения с гибкими шестами. Сразу после осуществления протокола, волонтеры оставались сидеть в покое в течение 60 минут и их ВСР анализировалась.

Результаты. Мы не наблюдали никаких изменений значения во временной области и частотной области показателей ВСР между до и после одного круга с упражнений с гибким шестом.

Заключение. Один круг упражнений с гибким шестом не вызвать значительные изменения в геометрических и линейных показателях ВСР.

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Ключевые слова: сердечно-сосудистая система, вегетативная нервная система, лечебная физкультура.

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Specific changes are necessary to maintain cardiac system homeostasis during exercise activity. Those responses are promoted by the action of the autonomic nervous system on the heart [1]. The usual cardiac autonomic reaction to exercise presents abrupt parasympathetic withdrawal during the beginning of exercise leading to heart rate increase and following increase in the sympathetic nervous system activity. After exercise cessation heart rate reduces due to the vagal reactivation mechanism [2].

Cardiac autonomic regulation can be evaluated through heart rate variability (HRV) is a well recognized non-invasive method. HRV evaluates the oscillations in the intervals between consecutive heart beats (RR intervals) that are associated with the influences of the autonomic nervous system on the sinus node [3]. Alterations in HRV after exercise are featured by reduced vagal tone and global variability of HRV and progressive increase in HRV [4].

A recent instrument that is used for musculoskeletal rehabilitation is the flexible pole. It is an instrument that permits muscle contractions generated by co-contraction of the muscle groups of the upper limb [5], inducing isometric contractions of the shoulder and trunk muscles [6, 7].

Although flexible pole exercise has been used in musculoskeletal rehabilitation programs [6], to the best of our knowledge, no study concerning its effects on autonomic nervous system was found in the literature. Moreover, isometric contractions were shown to change parasympathetic component of HRV [8]. In this circumstance, we endeavored to evaluate the acute effects of a standardized exercise with flexible pole on cardiac autonomic regulation.

Material and methods

Study Population. Subjects were 23 healthy female students, all nonsmokers, aged between 18 and 25 years. All volunteers were informed about the procedures and objectives of the study and gave written informed consent. All study procedures were approved by the Ethics Committee in Research of the Faculty of Sciences of the Universidade Estadual Paulista, Campus of Marilia (No. 0554-2012), and were in accordance with Resolution 196/96 National Health 10/10/1996.

Non-inclusion criteria. We did not include subjects that reported the following conditions: cardiopulmonary, psychological, neurological related disorders and other impairments that prevent the subject known to perform procedures, and treatment with drugs that influence cardiac autonomic regulation. Volunteers were not evaluated on 10-15 days and 20-25 days after the first day of the menstrual cycle [9]. We also excluded physically active subjects according to the International Physical Activity Questionnaire (IPAQ) [10].

Initial Evaluation. Prior to the study, baseline criteria included: age, gender, weight, height and body mass index (BMI). Weight was determined using a digital scale (W 200/5, Welmy, Brazil) with a precision of 0,1 kg. Height was determined using a stadiometer (ES 2020, Sanny, Brazil) with a precision of 0,1 cm and 2,20 m of extension. Body mass index (BMI) was calculated as weight / height^2, with weight in kilograms and height in meters [11, 12].

HRV analysis. The R-R intervals recorded by the portable RS800CX heart rate (HR) monitor (with a sampling rate of 1000 Hz) were downloaded to the Polar Precision Performance program (v. 3.0, Polar Electro, Finland). The software enabled the visualization of HR and the extraction of a cardiac period (R-R interval) file in "txt" format. Following digital filtering complemented with manual filtering for the elimination of premature ectopic beats and artifacts, at least 256 R–R intervals were used for the data analysis. Only series with more than 95% sinus rhythm was included in the study [3]. For calculation of the linear indices we used the HRV Analysis software (Kubios HRV v.1.1 for Windows, Biomedical Signal Analysis Group, Department of Applied Physics, University of Kuopio, Finland) [11, 12].

We used Kubios HRV version 2.0 software to analyze all HRV indices.

Linear indices and Geometric analysis of HRV. To analyse HRV in the frequency domain, the low frequency (LF=0,04–0,15 Hz) and high frequency (HF=0,15–0,40 Hz) spectral components were used in ms^2 and normalized units (nu), representing a value relative to each spectral component in relation to the total power minus the very low frequency (VLF) components, and the ratio between these components (LF/HF). The spectral analysis was calculated using the Fast Fourier Transform algorithm [11-13].

The analysis in the time domain was performed in terms of SDNN (standard deviation of normal-to-normal R-R intervals), pNN50 (percentage of adjacent RR intervals with a difference of duration greater than 50 ms) and RMSSD (root-mean square of differences between adjacent normal RR intervals in a time interval) [11-13].

The geometric analysis was performed using the following geometrical methods: RRtri, TINN and Poincaré plot (SD1, SD2 and SD1/SD2 ratio). The RRtri was calculated from the construction of a density histogram of RR intervals, which contains the horizontal axis of all possible RR intervals measured on a discrete scale with 7,8125 ms boxes (1/128 seconds) and on the vertical axis, the frequency with which each occurred. The union of points of the histogram columns forms a triangle-like shape. The RRtri was obtained by dividing the number of RR intervals used to construct the histogram by their modal frequency (i.e., the RR interval that most frequently appeared on RR) [11-13].

The TINN consists of the measure of the base of a triangle. The method of least squares is used to determine the triangle. The RRtri and the TINN express the overall variability of the RR intervals [3].

The Poincaré plot is a map of points in Cartesian coordinates that is constructed from the values of the RR intervals. Each point is represented on the x-axis by the previous normal RR interval and on the y-axis by the following RR interval [3, 11, 12].

For the quantitative analysis of the plot, an ellipse was fitted to the points of the chart, with the center determined by the average RR interval. The SD1 indices were calculated to measure the standard deviation of the distances of the points from the diagonal y=x, and SD2 measures the standard deviation of the distances of points from the line y=-x+RRm, where RRm is the average RR interval. The SD1 is an index of the instantaneous recording of the variability of beat-to-beat and represents the parasympathetic activity, whereas the SD2 index represents the long-term HRV and reflects the overall variability. The SD1/SD2 shows the ratio between the short- and long-term variation among the RR intervals [3].

The plot was qualitatively analyzed using HRV analysis software based on the figures formed by its attractor. The expected shapes were described by Tulppo et al. [14] as: figures in which an increase in the dispersion of RR intervals is observed with increased intervals, characteristic of a normal plot, and, small figures with beat-to-beat global dispersion without increased long-term dispersion of RR intervals [11, 12].

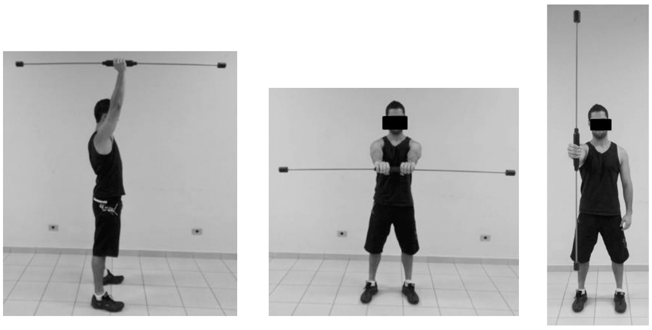
Protocol. Data collection was undertaken in the same sound-proof room for all volunteers with the temperature between 21°C and 25°C and relative humidity between 50 and 60% and volunteers were instructed not to drink alcohol and caffeine for 24 hours before evaluation. Data were collected on an individual basis, between 8 and 12 AM to standardize the protocol. All procedures necessary for the data collection were explained on an individual basis and the subjects were instructed to remain at rest and avoid talking during the collection [11, 12].

After the initial evaluation the heart monitor belt was then placed over the thorax, aligned with the distal third of the sternum and the Polar RS800CX heart rate receiver (Polar Electro®, Finland) was placed on the wrist. Before starting the exercises, the volunteers received visual feedback through a monitor to maintain neutral posture standing and were instructed to maintain the same posture throughout the exercise. Systolic and diastolic blood pressure was measured before, immediately after exercise and 60 minutes after exercise. The oscillatory movement of the flexible pole (Flexibar®) was held by flexion and elbow extension. The flexible pole vibrated at a frequency of 5 Hz, and the oscillation frequency of the flexible pole was based on an auditory stimulation through a metronome (Quartz Metronome®) calibrated at 300 bpm [11-15].

The exercises with the flexible pole were conducted with volunteers at standing position with feet apart (wide base) and shoulder flexion as the proposed position. To maintain the proper shoulder flexion in each upper limb it was used as a target visual feedback. All exercises were performed for 15 seconds with 50-60 seconds of rest between each exercise. Three repetitions were performed for each exercise [7].

The exercises were performed on three positions: 1) with one shoulder at approximately 180° of flexion with the flexible pole on the frontal plane, parallel to the ground (Figure 1A), 2) with two shoulders on 90° of flexion with the flexible pole on the transverse plane (Figure 1B), and 3) one shoulder at 90° of flexion with the flexible pole on the sagittal plane, perpendicular to the ground (Figure 1C). HRV was analyzed at the following periods: control rest, 0-5 min, 5-10 min, 10-15 min, 15-20 min, 20-25 min and 25-30 min after the protocol exercise [11, 12].

Statistical Analysis. Standard statistical methods were used to calculate the means and standard deviations. The normal Gaussian distribution of the data was verified by the Shapiro-Wilk goodness-of-fit test (z value of >1,0). For parametric distributions we applied ANOVA for repeated measures followed by the Bonferroni posttest. For non-parametric distributions we used the Friedman test followed by Dunn's posttest. Differences were considered significant when the probability of a Type I error was less than 5% ($p<0{,}05$). We used Biostat 2009 Professional 5.8.4 software.



A B C

Figure 1. Exercise protocol with flexible pole at the three positions: 1) with shoulders at approximately 180° of flexion with the flexible pole on the frontal plane, parallel to the ground (A); 2) with the shoulder on 90° of flexion with the flexible pole on the transverse plane (B); and 3) shoulders at 90° of flexion with the flexible pole on the sagittal plane, perpendicular to the ground (C).

Table 1

Data on baseline mean RR interval, age, height, body weight and body mass index of the volunteers

Variable	Value
Age (years)	20,4±2
Height (m)	1,72±0,05
Weight (kg)	72,9±5
BMI (kg/m^2)	25,05±2,6
HR (bpm)	81,7±11
Mean RR (ms)	752,8±117

Abbreviations: HR — baseline heart rate, Mean RR — mean RR interval, BMI — body mass index, m: meters, kg: kilograms, bpm: beats per minute, ms: milliseconds.

Results

Data on baseline mean RR interval, age, height, body weight and body mass index (BMI) are presented in Table 1.

We note the behavior of systolic and diastolic arterial blood pressure, HRV in the time and frequency domain indices before and after a single bout of exercise with flexible pole in Table 2. The SDNN, RMSSD and pNN50 indices in the time domain were not significantly changed after a standardized exercise with flexible pole and the frequency domain indices (LF: nu and ms^2; HF: nu and ms^2 and LF ratio) did not present significant responses induced by a single bout of exercise with flexible pole (Table 2).

According to Figure 2 we observe that the linear geometric indices of HRV (RRTri and TINN) were not significantly changed after one session of exercise with

Table 2

Diastolic and systolic arterial pressure before, time and frequency domain indices before and after a standardized exercise protocol with flexible pole

Variable	Rest	0-5min	5-10 min	10-15 min	15-20 min	20-25 min	25-30 min
SAP (mmHg)	112,3±10	114,3±10	-	-	-	-	110,6±11
DAP (mmHg)	78,3±9	75±10	-	-	-	-	77,8±10
LF (ms^2)	910±608	773±636	663±429	796±621	718±434	904±802	875±586
HF (ms^2)	455±318	407±504	418±423	467±459	439±448	478±441	507±472
LF (nu)	65,3±16	69,4±18	64,6±13	64,8±15	65,9±15	66,8±15	67,7±13
HF (nu)	34,6±16	30,5±18	35,3±13	35,4±15	34±15	33,1±15	32,2±13
LF/HF	3,2±4	3,28±2,3	2,33±1,49	2,87±3,2	2,64±1,81	3,08±2,6	2,61±1,41
SDNN	44,6±12	40,9±17	39,1±12	42,3±13	40,7±11	41,3±14	43,8±17
RMSSD	31,07±12	28,2±17	27±15	28,3±14	28,4±14	29,2±16	29,6±15
pNN50	12,4±10	10,2±14	8,9±11	10,2±11	9,7±11	10,3±12	10,7±11

Abbreviations: DAP — diastolic arterial pressure, SAP — systolic arterial pressure, SDNN — standard deviation of normal-to-normal R-R intervals, pNN50 — percentage of adjacent RR intervals with a difference of duration greater than 50ms, RMSSD — root-mean square of differences between adjacent normal RR intervals in a time interval, LF — low frequency, HF — high frequency, LF/HF — low frequency/high frequency ratio, ms — milliseconds, mmHg — millimeters of mercury.

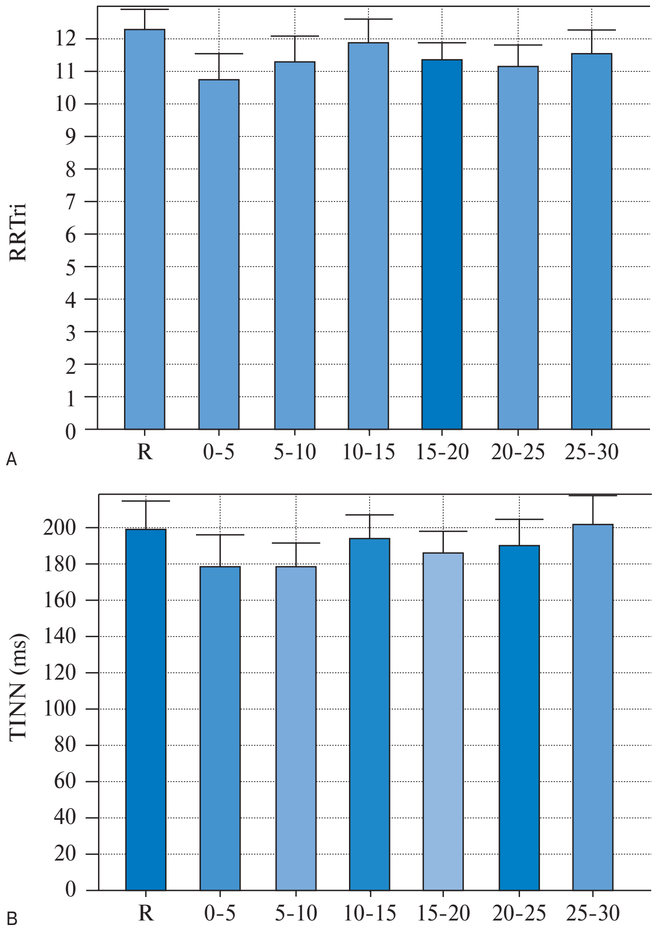


Figure 2. RRTri (A) and TINN (B) indices before and after standardized exercise protocol with flexible pole. RRTri: Triangular index; TINN: triangular interpolation of RR intervals.

flexible pole. Moreover, the Poincaré plot indices (SD1, SD2 and SD1/SD2 ratio) did not present significant between before and after the exercise protocol (Figure 3).

An example of the Poincaré plot patterns is presented in Figure 4. The plot is presented in one subject during the control condition before exercise (A), 0-5 min (B), 5-10 min (C), 10-15 min (D), 15-20 min (E), 20-25 min (F) and 25-30 min (G) after a standardized exercise protocol with flexible pole.

Discussion

The autonomic nervous system is influenced by isometric and rhythmic exercise, since the literature indicated that sympathetic outflow to the skin increases during this style of exercise [15-17]. Isometric leg extension and isometric handgrip were also reported to elicit cardiovascular responses characterized by increase in skin sympathetic nerve activity [18]. In this context, flexible pole is a tool used for rehabilitation therapies that induces isometric contraction of the shoulder and trunk muscles [7, 19]. In order to investigate a standardized protocol with this instrument for cardiac rehabilitation we evaluated the acute effects of a single bout of exercise with flexible pole on cardiac autonomic regulation. As a main finding, we observed that this standardized exercise protocol did not induce significant responses of diastolic and systolic arterial pressure and HRV indices analyzed in the time and frequency domain and also through analysis of geometric indices.

After endurance exercise it is observed the usual post-exercise hypotension, which is defined as a reduction of arterial blood pressure compared to the pre-exercise baseline levels [20]. A previous study reported that blood pressure was increased in young men during static exercise at 40% of maximal voluntary contraction [21]. The literature supports this result indicating that activation of the muscle chemoreflex during sustained isometric contractions increases blood pressure through increase in muscle sympathetic nerve activity [22]. However, based on our findings, there was no significant response of arterial blood pressure after the standardized exercise with oscillatory

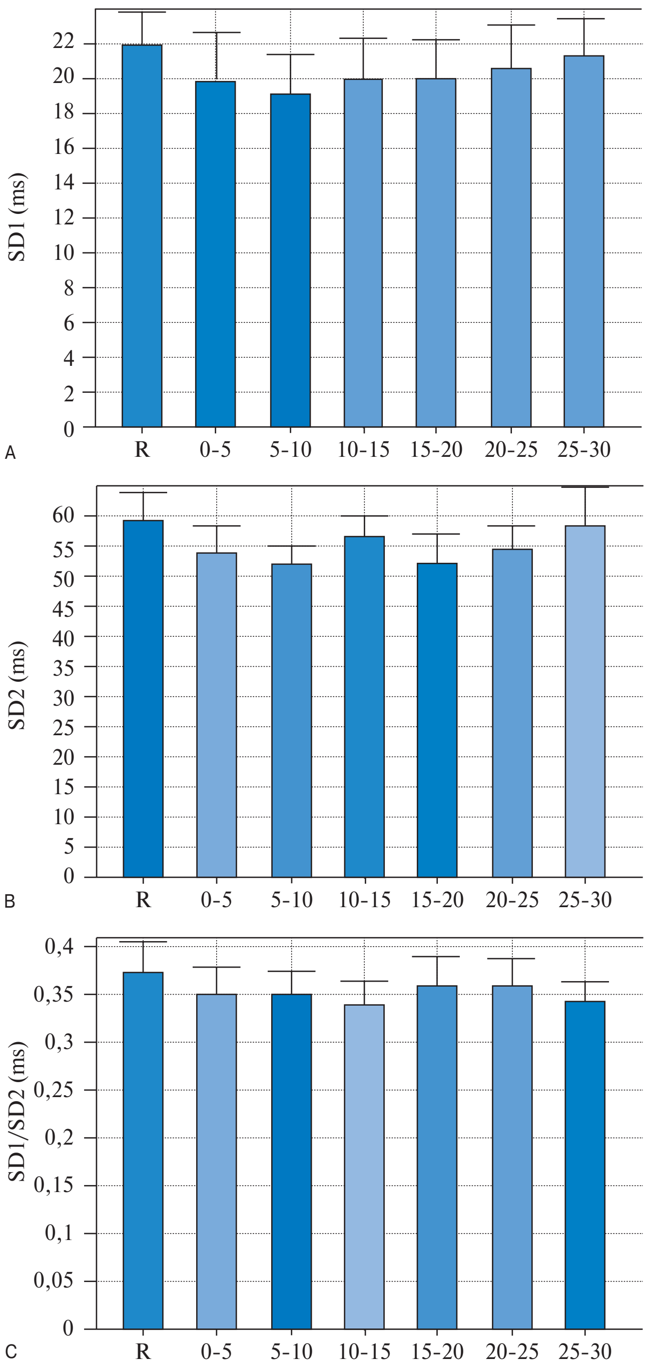


Figure 3. SD1 (A), SD2 (B) and SD1/SD2 (C) ratio before and after a standardized exercise protocol with flexible pole. SD1 — standard deviation of the instantaneous variability of the beat-to beat heart rate; SD2 — standard deviation of long-term continuous RR interval variability; SD1/SD2 ratio — ratio between the short — and long — term variations of RR intervals.

pole. In this sense, we believe that the intensity of the protocol exercise used in our study that was based on previous investigation [7, 19], was the main explanation for the absence of significant responses of arterial pressure during the recovery phase.

We reported absence of significant cardiac autonomic responses induced by a single bout of standardized exer-

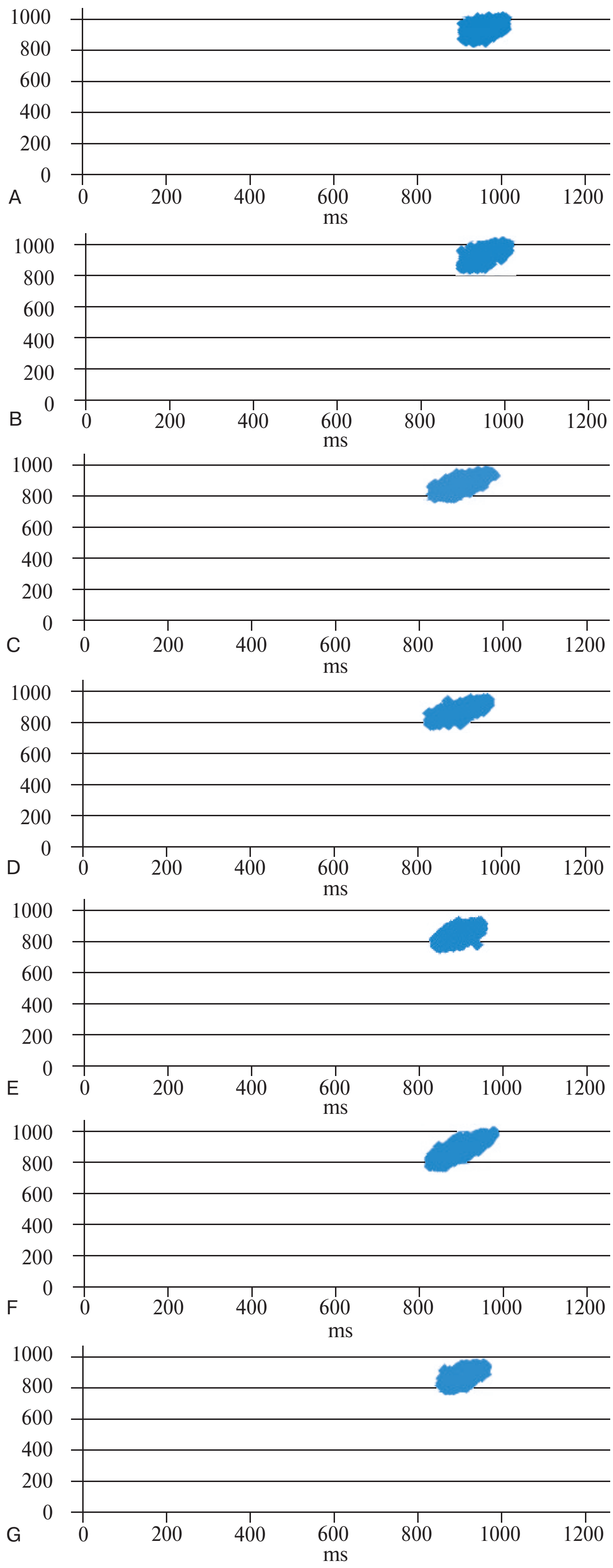


Figure 4. Visual pattern of the Poincaré plot observed in one subject during the control condition before exercise (A), 0-5 min (B), 5-10 min (C), 10-15 min (D), 15-20 min (E), 20-25 min (F) and 25-30 min (G) after a single bout of exercise with flexible pole.

cise with flexible pole. The literature indicated that endurance and strength exercises acutely elicit parasympathetic withdrawal during exercise and vagal reentrance immediately after exercise cessation [2]. Another investigation reported that cardiac autonomic control is not completely recovered within 30 minutes of acute endurance or resistance exercise [23]. This physiological response is based on central command and muscle chemoreflex, two mechanisms proposed to explain the typical pressor response to exercise. The central command is an efferent response triggered by parallel activation of the cardiovascular control centers and the motor cortex. The muscle chemoreflex is a reaction induced by chemosensitive afferent nerve fibers located in the exercising muscles [24]. Immediately after exercise cessation, there is a reduction of inputs from the central nervous system and from the receptors in skeletal muscle, leading to a sudden exponential decrease in heart rate, due to the vagal reactivation [25]. Nonetheless, this expected response was not observed in our study. We may conclude that this is due to the intensity of exercise that was based on auditory stimulation through a metronome calibrated at 300 bpm and also based on the period the subjects performed each exercise, i.e. 15 seconds.

HRV analysis was performed in the linear time and frequency domain indices as well as through Poincaré plot indices (SD1, SD2 and SD1/SD2 ratio). The SD1 index corresponds to the dispersion of points perpendicular to the line of identity and reflects the variability of short-term, it corresponds to the standard deviation of instantaneous beat to beat variability and is an indicator of vagal cardiac modulation. The SD2 index corresponds to the dispersion of the points along the line of identity and indicates the HRV in long-term record, indicating the standard deviation of long-term continuous RR intervals (RR+1) and is an indicator of sympathetic and parasympathetic cardiac modulation [23]. The Poincaré plot analysis is considered nonlinear because it analyzes the nonlinear dynamics of a phenomenon that is able to detect the hidden correlation patterns of a time series signal [27]. Nonlinear analysis is indicated to be related to the genesis of heart rate dynamics [28]. Moreover, this method of analysis of HRV is suggested to be more sensitivity to identify alterations in cardiac autonomic regulation compared to the linear analysis of HRV [28]. Although those indices that are more sensitive were not significantly changed between before and after exercise with flexible pole, we stimulate new studies to investigate the safety of this standardized exercise protocol in patients with cardiovascular diseases.

In our study we did not evaluate physically active subjects according to the International Physical Activity Questionnaire. A recent study demonstrated different recovery of cardiac autonomic regulation after a treadmill test until voluntary exhaustion between moderately trained and highly trained wrestlers. The authors reported that the SD1 index presented faster recovery in the moderate group compared to the high trained group [29].

Ogata et al [11] (2014) and Antonio et al [12] (2014) have performed a similar protocol with flexible pole, the authors conducted the study with young men and concluded that a single bout of exercise with a flexible pole reduced the HRV and parasympathetic recovery was observed approximately 30 min after exercise. In this context, Antonio et al conducted exercise with flexible pole in 32 young women, however, there were no significant differences between the indices of heart rate variability; the difference between these studies was the performance of the exercise, either using one arm sometimes with both arms. In our research we investigated the geometric indices (RRtri and TINN) of HRV and indices derived from the Poincaré plot (SD1, SD2 and SD1 / SD2 ratio). On the other hand, the analysis of these new indices showed no significant difference.

Another point to be raised in our study is that we evaluated only women in order to avoid sex-dependent effects on HRV responses induced by exercise. The literature indicated differences between women and men in relation to cardiac autonomic responses after a section of exercise [29]. In this sense, we should be careful when extrapolating this data to different population.

Exercises with flexible pole have been used as complementary tool to treat or improve shoulder muscles physical capacities in physical therapy rehabilitation programs [11, 12, 17]. Nevertheless, after an extensive review on Medline/Pubmed database, we observed that this is the first investigation to analyze the effects of a single bout of a standardized exercise with flexible pole on HRV in healthy adult women. Severe alterations in cardiac autonomic modulation elicited by stress or exercises can lead to cardiac events such as sudden death [11, 30], the maintenance of HRV after the intervention protocol supports the safety of this exercise style for patients with cardiovascular disorders.

Conclusion

A single bout of exercise with flexible pole did not elicit significant changes in geometric and linear indices of heart rate variability. Additional studies are suggested to evaluate the chronic effects of this exercise protocol.

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BEHAVIOUR OF GLOBALLY CHAOTIC PARAMETERS OF HEART RATE VARIABILITY FOLLOWING A PROTOCOL OF EXERCISE WITH FLEXIBLE POLE

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Aim. The aim of this study was to evaluate the effect of flexible pole exercise on cardiac autonomic modulation. This was investigated while at rest before and, then in the recovery phase from the flexible pole exercise.

Material and methods. Thirty-two female subjects were allocated to equal groups. The analysis of cardiac autonomic modulation was through the recording of temporal separations of interpeak RR intervals taken from the heart rate monitor. The analysis was performed by chaotic global measures of heart rate variability (HRV). Two parameters were proposed based on the greater resolution of multi-taper method (MTM) power spectra. They were high spectral entropy (*hs*Entropy) and high spectral detrended fluctuation analysis (*hsDFA*) and were applied owing to the greater parametric response in short data series. After applying Anderson-Darling and Lilliefors tests for confirmation of high non-normality; Kruskal-Wallis test of significance was used for the statistical analysis, with the level of significance moderately set at (p<0.15).

Results. On recovery from flexible pole exercise there was a significant decrease in three of the combinations of CFP. The algorithm which applied all three chaotic global parameters was the optimum statistically measured by Kruskal-Wallis and standard deviation. It was also the most influential by principal component analysis (PCA) with almost all variation covered by the first two components.

Conclusion. Flexible pole exercise leads to a further significant decrease in chaosity measured by the combination of chaotic globals.

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Key words: cardiovascular system, autonomic nervous system, flexible pole exercise, chaotic globals.

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HRV — heart rate variability, IPAQ — International Physical Activity Questionnaire, MTM — multi-taper method, ANS — autonomic nervous system, sDFA — Detrended Fluctuation Analysis, DPSS — discrete prolate spheroidal sequences, CFP — Chaotic Forward Parameter, PCA — Principal Component Analysis.

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ПОВЕДЕНИЕ ГЛОБАЛЬНО ХАОТИЧЕСКИХ ПАРАМЕТРОВ ВАРИАБЕЛЬНОСТИ СЕРДЕЧНОГО РИТМА ПОСЛЕ ПРОТОКОЛА ТРЕНИРОВКИ С ГИБКИМ ШЕСТОМ

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Цель. Целью данного исследования явилась оценка влияния упражнения с гибким шестом на кардиальную вегетативную модуляцию. Исследование было проведено в состоянии покоя до и, затем в фазе восстановления после выполнения упражнения с гибким шестом.

Материал и методы. Тридцать две женщины были разделены на две равные группы. Анализ кардиальной вегетативной модуляции проводился путем регистрации временных разделений interpeak RR интервалов, полученных при мониторировании сердечного ритма. Анализ проводился хаотическими глобальными измерениями вариабельности сердечного ритма (ВСР). Предполагалось, что два параметра были основными в большем разрешение мульти-конического метода (МТМ) спектра мощности. Это были методы высокой спектральной энтропии (hsEntropy) и анализа высокого спектрального колебания с исключенным трендом (hsDFA) и были применены как обладающие большим параметрическим ответом при исследованиях коротких периодов данных. После применения тестов Андерсона-Дарлинга и Lilliefors для подтверждения высокой аномальности, тест значимости Крускала-Уоллиса был использован для статистического анализа, среднем при уровне значимости (p<0,15).

Результаты. При восстановлении после тренировки с гибким шестом наблюдалось значительное снижение трех комбинаций из CFP. Алгоритм, который применяется во всех трех хаотических глобальных параметрах, статистически оптимально измеряется Крускала-Уоллиса и стандартным отклонением. Он также является самым влиятельным методом главного компонентного анализа с большинством вариаций, которые охватывают первые два компонента.

Заключение. Упражнение с гибким шестом приводит к дальнейшему значительному снижению chaosity и измеряется сочетанием хаотических глобальных измерений.

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Ключевые слова: сердечно-сосудистая система, вегетативная нервная система, упражнения с гибким шестом, хаотические глобальные измерения.

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During the aerobic exercise the increased parasympathetic withdrawal and sympathetic activity elicit heart rate increase and reduce heart rate variability (HRV). Immediately after exercise the parasympathetic reactivation is responsible for heart rate recovery and HRV increase [1]. The flexible pole is an instrument with mass 0,8 kg and around 150 cm in length. This tool provides oscillation caused by periodic movements of the upper limbs. The frequency of the flexible pole provides resistance during exercises. Exercise protocols using the flexible pole were shown to present positive results in shoulder muscle function training [2]. However, it is not clear the quantitative level or direction of cardiac autonomic response after a standardized protocol of exercise with this instrument. Thus, this study aimed to investigate the acute effects of an exercise protocol with flexible pole on the globally chaotic parameters of HRV.

Material and methods

Study Population. The subjects were 32 healthy female students, all nonsmokers, aged between 18 and 25 years. All volunteers were informed about the procedures and objectives of the study and gave written informed consent. All study procedures were approved by the Ethics Committee in Research of the Faculty of Sciences of the Universidade Estadual Paulista, Campus of Marilia (No. 0554-2012), and were in accordance with Resolution 196/96 National Health 10/10/1996.

We did not include subjects that reported the following conditions: cardiopulmonary, psychological, neurological related disorders and other impairments that prevent the subject known to perform procedures, and treatment with drugs that influence cardiac autonomic regulation. Volunteers were not evaluated on 10-15 days and 20-25 days after the first day of the menstrual cycle [3]. We also excluded physically active subjects according to the International Physical Activity Questionnaire (IPAQ) [4].

Initial Evaluation. Baseline information collected included: age, gender, weight, height and body mass index (BMI). Weight was determined using a digital scale (W 200/5, Welmy, Brazil) with a precision of 0.1 kg. Height was determined using a stadiometer (ES 2020, Sanny, Brazil) with a precision of 0.1 cm and 2.20 m of extension. BMI was calculated with weight in kilograms and height in meters.

Exercise with flexible pole. The exercises with the flexible pole were conducted with volunteers at standing position with feet apart (wide base) and shoulder flexion as the proposed position. To maintain the proper shoulder flexion in each upper limb it was used as a target visual feedback. All exercises were performed for 15 seconds with 50-60 seconds of rest between each exercise. Three repetitions were performed for each exercise. HRV was analyzed during 10 min at control rest and during 10 min during recovery from the exercise protocol. (Figure 1)

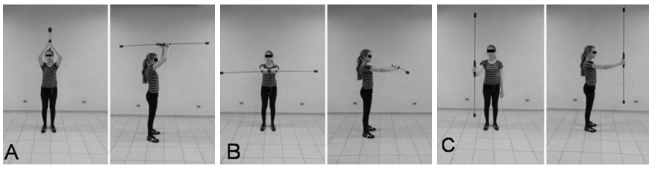

Figure 1. The exercise protocol was composed by the following exercise with both arms on three positions: i) with shoulders at approximately 180° of flexion with the flexible pole on the frontal plane, parallel to the ground (Figure 1A), ii) with the shoulders on 90° of flexion with the flexible pole on the transverse plane (Figure 1B), and iii) one shoulder at 90° of flexion with the flexible pole on the sagittal plane, perpendicular to the ground (Figure 1C).

HRV analysis. The RR intervals recorded by the portable HR monitor (with a sampling rate of 1000 Hz) were downloaded to the Polar Precision Performance program (v.3.0, Polar Electro, Finland). The software enabled the visualization of HR and the extraction of a cardiac period (RR interval) file in “txt” format. Following digital filtering complemented with manual filtering for the elimination of premature ectopic beats and artefacts, 500 RR intervals were used for the data analysis. Only series with sinus rhythm greater than 95% were included in the study.

Protocol. Data collection was undertaken in the same soundproof room for all volunteers; the temperature was between 21°C and 25°C and the relative humidity was between 50 and 60%. Volunteers were instructed not to drink alcohol, caffeine or other autonomic nervous system (ANS) stimulants for 24 hours before the evaluation. Data were collected on an individual basis, always between 18:00 and 21:00 to avoid circadian influences. All procedures necessary for the data collection were explained to each subject separately, and the subjects were instructed to remain at rest and avoid talking during the collection. HRV was analysed in the following periods: control protocol — the 10-minute periods before the performance of the task and the 5-minute periods during the performance of the test.

Chaotic Assessment

Multi-Taper Method: Power Spectrum. A potential criticism in previous studies on diabetes [5] and childhood obesity [6] with respect to chaotic global parameters is that the spectral entropy [7] and spectral Detrended Fluctuation Analysis (sDFA) [8] analysis may be more sensitive if we applied the Shannon entropy [9, 10] and DFA [11, 12] algorithms to the multi-taper spectrum [13] rather than the Welch power spectrum [14]. Thus the spectra applied in all three chaotic global parameters would match. This is pertinent here since the number of RR interval is low at 500. Typically we have examined double this amount when applying Welch power spectrum [14] for spectral entropy and sDFA.

Multi-Taper Method (MTM) [13] is useful for spectral estimation and signal reconstruction, of a time series of a spectrum that may contain broadband and line compo-

Table 1

The table below shows the Kruskal-Wallis test of signficance by p-value of [CFP 1-7] for 500 RR intervals from control rest to recovering from the exercise protocol with flexible pole

Combination of Chaotic Globals [CFP1-7]	Kruskal Wallis (p-value)
CFP1	0,1397
CFP2	0,7935
CFP3	0,0469
CFP4	0,2482
CFP5	0,4809
CFP6	0,1379
CFP7	0,5063

nents. MTM is non-parametric since it does not apply an *a priori*, parameter dependent model of the process that generated the time series under analysis. MTM reduces the variances of spectral estimates by using a small set of tapers. Data is pre-multiplied by orthogonal tapers created to minimize the spectral leakage owing to the finite length of the time series. A set of independent approximations of the power spectrum is calculated. Functions identified as discrete prolate spheroidal sequences (DPSS) [15] optimize the tapers. They are defined as eigenvectors of a Rayleigh-Ritz minimization problem [16].

Chaotic Globals. *High spectral* entropy (*hs*Entropy) is a function of the irregularity of amplitude and frequency of the power spectrums peaks. It is derived by applying Shannon entropy to the MTM power spectrum. The parameters for MTM are: (i) sampling frequency of 1Hz; (ii) time bandwidth for the DPSS is 3; (iii) FFT length of 256; (iv) Thomson's adaptive nonlinear combination method to combine individual spectral estimates. This output is then normalized so that the sum of the magnitude is equal to unity; giving a normalized power spectrum. We then calculate an intermediate parameter which is the median Shannon entropy of the value obtained from three different power spectra using the MTM power spectra under three test conditions: a perfect sine wave, uniformly distributed random variables, and finally the experimental oscillating signal. These values are then again normalized mathematically so that the sine wave gives a value of zero, uniformly random variables give unity, and the experimental signal between zero and unity. It is this final value that corresponds to *hs*Entropy.

To obtain *high spectral* Detrended Fluctuation Analysis (*hs*DFA) we calculate the spectral adaptation in exactly the same way as for *hs*Entropy using a MTM power spectrum with the same settings; but DFA rather than Shannon entropy is the algorithm applied.

Spectral Multi-Taper Method (sMTM) [8] is founded on the increased intensity of broadband noise in power spectra generated by irregular and chaotic signals. sMTM is the area between the MTM power spectrum and the baseline.

Chaotic Forward Parameter. The parameter [CFP 1-7] is referred to as Chaotic Forward Parameter for the functions 1 to 7 below where it is applied to at rest and recovery from flexible pole datasets. Since *hs*DFA responds to chaos in the opposite way to the others we subtract its value from unity when applying here. All three chaotic global values have equal weightings. In Figures 2 and 3 for the vertical axis: CFP1 applies all three chaotic global parameters (*hs*Entropy)(1-*hs*DFA)(sMTM); CFP2 includes (*hs*Entropy)(1-*hs*DFA); CFP3 (*hs*Entropy)(sMTM); CFP4 (1-*hs*DFA)(sMTM); CFP5 (1-*hs*DFA); CFP6 (sMTM); CFP7 (*hs*Entropy). These are illustrated in the equations below.

$$[CFP\,1]=\left[\left\{\left[\frac{hsEntropy}{\max(hsEntropy)}\right]\right\}^2+\left\{\left[\frac{sMTM}{\max(sMTM)}\right]\right\}^2+\left\{1-\left[\frac{hsDFA}{\max(hsDFA)}\right]\right\}^2\right]^{\frac{1}{2}}$$

$$[CFP\,2]=\left[\left\{\left[\frac{hsEntropy}{\max(hsEntropy)}\right]\right\}^2+\left\{1-\left[\frac{hsDFA}{\max(hsDFA)}\right]\right\}^2\right]^{\frac{1}{2}}$$

$$[CFP\,3]=\left[\left\{\left[\frac{hsEntropy}{\max(hsEntropy)}\right]\right\}^2+\left\{\left[\frac{sMTM}{\max(sMTM)}\right]\right\}^2\right]^{\frac{1}{2}}$$

$$[CFP\,4]=\left[\left\{\left[\frac{sMTM}{\max(sMTM)}\right]\right\}^2+\left\{1-\left[\frac{hsDFA}{\max(hsDFA)}\right]\right\}^2\right]^{\frac{1}{2}}$$

$$[CFP\,5]=\left[\left\{1-\left[\frac{hsDFA}{\max(hsDFA)}\right]\right\}^2\right]^{\frac{1}{2}}$$

$$[CFP\,6]=\left[\left\{\left[\frac{sMTM}{\max(sMTM)}\right]\right\}^2\right]^{\frac{1}{2}}$$

$$[CFP\,7]=\left[\left\{\left[\frac{hsEntropy}{\max(hsEntropy)}\right]\right\}^2\right]^{\frac{1}{2}}$$

Statistical Analysis. Parametric statistics assume the data are normally distributed, using the mean as a measure of central tendancy. If we cannot normalize the data we should not compare means. To test our assumptions of normality we apply the Anderson-Darling [17] test and the Lilliefors [18] test. Here in most cases the p<0,01; for both, therefore we have a probability plot of highly non-normal data and so we must apply the non-parametric Kruskal-Wallis test of signficance. The Kruskal-Wallis algorithm computes a significant statistical result for three of the seven combinations (p<0,15). These are combinations [CFP 1, 3 & 6].

Results

Principal Component Analysis (PCA) [19] is the multivariate technique applied. We have seven values of Chaotic Forward Parameter. Therefore, seven groups of thirty-two subjects for the *difference* between at control rest; to those recovering from exercise with flexible pole. Hence, CFP recovery from exercise subtracted from CFP at rest prior to exercise. A grid of 7 by 32 to be assessed. The First Principal Component (PC1) has a variance (eigenvalue) of 5,5253 and accounts for 78,9% of the total variance. The Second Principal Component (PC2) has an eigenvalue of 1,4662 accounting for 99,9% of cumulative total variance. PC2 accounting for 20,9% of its proportion of the variance. Therefore we can assume that most variance is acheived in the first two components.

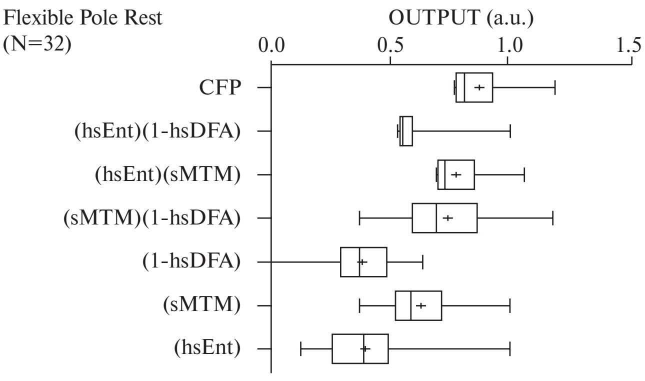

Figure 2. The boxplots illustrate the mean values and standard deviation of [CFP 1-7] for the RR intervals of subjects at control rest. Mean values are indicated by the (+) symbol. The number of RR intervals is 500 and number of subjects is 32.

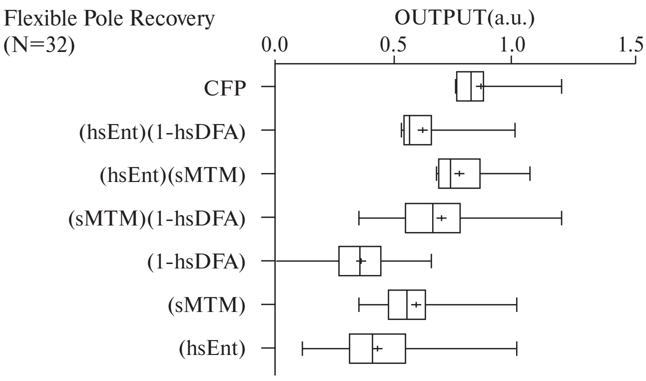

Figure 3. The boxplots illustrate the mean values and standard deviation of [CFP 1-7] for the RR intervals of subjects recovering from flexible pole exercise. The number of subjects is 32 and number of RR intervals is 500. Mean values are indicated by the (+) symbol.

Table 2

The table below shows the minimum, maximum, median and the 25th (Q1) and 75th (Q3) percentile of [CFP 1-7] for 500 RR intervals from before the exercise protocol with flexible pole

Combination of Chaotic Globals [CFP1-7]	Before Exercise Minimum	Before Exercise Q1	Before Exercise Median	Before Exercise Q3	Before Exercise Maximum
CFP1	0,7725	0,7826	0,8086	0,9271	1,1898
CFP2	0,5311	0,5365	0,5489	0,5952	1,0000
CFP3	0,6993	0,7020	0,7246	0,8492	1,0657
CFP4	0,3683	0,5965	0,6921	0,8639	1,1829
CFP5	0,0000	0,2922	0,3705	0,4849	0,6319
CFP6	0,3683	0,5200	0,5845	0,7150	1,0000
CFP7	0,1275	0,2548	0,3860	0,4908	1,0000

Table 3

The table below shows the minimum, maximum, median and the 25th (Q1) and 75th (Q3) percentile of [CFP 1-7] for 500 RR intervals for after exercise protocol with flexible pole

Combination of Chaotic Globals [CFP1-7]	After Exercise Minimum	After Exercise Q1	After Exercise Median	After Exercise Q3	After Exercise Maximum
CFP1	0,7544	0,7629	0,7952	0,8659	1,1978
CFP2	0,5292	0,5350	0,5571	0,6467	1,0000
CFP3	0,6766	0,6800	0,7048	0,8568	1,0597
CFP4	0,3507	0,5392	0,6539	0,7667	1,1923
CFP5	0,0000	0,2582	0,3586	0,4404	0,6493
CFP6	0,3507	0,4733	0,5468	0,6276	1,0000
CFP7	0,1151	0,3010	0,3990	0,5382	1,0000

[CFP 1] has the First Principal Component (0.154) and the Second Principal Component (-0,769). While, [CFP 3] has the First Principal Component (0.372) and the Second Principal Component (-0,398). Only the first two components need be considered due to the steep scree plot. [CFP 1, 3 & 6] only need to be considered on the basis of the Kruskal-Wallis test of significance at level p<0,15; 15% (Table 1). However since [CFP 6] only represents the increased intensity of broadband noise in the MTM power spectrum we do not consider it further. Consequently, [CFP 1] which applies all three chaotic globals techniques is the best overall combination with regards to influencing the correct outcome. This is on the basis of all three statistical tests — Kruskal-Wallis, Standard Deviation and PCA.

The results illustrate that there is a wide variation in both the mean values and standard deviation for both at control rest, and those with flexible pole during recovery stage (See Figures 2 and 3). In all these cases there is a *decrease* in chaotic response when going from at rest to recovery stage subjects. Tables 2 and 3 below show the minimum, maximum, median and the 25th (First Quartile, Q1) and 75th (Third Quartile, Q3) percentile of [CFP

1-7] for 500 RR intervals for before and after exercise protocol with flexible pole, respectively.

Discussion

Our study aimed to evaluate the cardiac autonomic responses through global chaotic parameters of HRV induced by a standardized protocol of exercise with flexible pole. We reported that this standardized exercise protocol was able to reduced HRV.

[CFP 1 & 3] are the main functions suitable as deduced by the three assessments (Kruskal-Wallis, Standard Deviation and PCA). There is evidence to apply [CFP 1] as the most robust function as with the optimization study by Garner and Ling [8]. This in addition to forward problems in youth and childhood obesity [6], diabetes mellitus [5] and COPD [20].

With regards to PCA applied to the seven different arrangements of chaotic globals subjects for the difference in at control rest to those recovering from exercise with flexible pole. 99.9% of influence is achieved by the first two principal components. The combination with all three chaotic globals applied testing as most influencial algorithm. Second best, and still significant across all three conditions by Kruskal-Wallis is the third algorithm which lacks the (1-*hs*DFA) parameter. It is important to recognize that in most cases the chaosity of the data *decreases* from subjects for those at control rest to those recovering from exercise with flexible pole. Applying the *hs*Entropy and *hs*DFA would seem to be advantageous with regards to the statistical tests here; compared to those standard techniques using Welch power spectra — spectral entropy and sDFA.

So, we have developed two robust functions which can take short time-series of HRV and discriminate between the control and experimental groups. There is a moderate level of significance for both these algorithms ($p<0.15$). By applying either of these novel functions to the shorter time-series via spectrally determined parameters it should be possible to determine which are at rest and those in recovery. This achieved more rapidly and efficiently with regards to time, data length and cohort group size. There has been a decrease in chaotic response of HRV following flexible pole exercise. The relationship between this form of exercise and complexity measures is useful in the risk assessment of dynamical diseases [21]. It identifies severity of the situation from a cheap and reliable method of monitoring the ANS. This is useful in treatments, assisting the determination of the level of physical and pharmacological intervention especially in related dynamical diseases.

Future development could involve the DPSS of the MTM being adjusted to optimize the final level of significance. In addition the weighting of the three chaotic global parameters could be modified since here they have only equal weightings of unity. It would also be statistically favourable to have larger, but equal datasets for both at rest and recovery subjects. If the time-series were longer this may also enhance statistical significances.

Conclusion

The chaotic response of HRV in subjects following flexible pole exercise is generally reduced and the parameter which applies all three parameters is the most influential and statistically most significant. At rest and during the recovery stage there is generally a decrease in chaosity of HRV. It is also the case that the use of the high spectral chaotic globals in the function achieves greater significance by Kruskal-Wallis, for a fraction of the length of time-series and low number of subjects. It quantifies the effectiveness of flexible pole exercise on cardiac autonomic modulation.

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PROGNOSTIC VALUE OF DIFFERENT OBESITY MARKERS FOR CARDIOVASCULAR RISK ASSESSMENT IN URBAN EMPLOYED MONGOLIANS

Protasov K. V.[1], Myagmarsuren T.[2]

We assessed the prevalence of obesity and identify obesity-related markers of elevated/high cardiovascular risk among urban employed Mongolians. 1277 railway workers aged 18-63 were investigated. Obesity parameters, blood pressure, lipids and fasting plasma glucose levels were measured. Body composition by bioelectrical impedance method was evaluated. 10-year risk for cardiovascular events was calculated. The results showed that the prevalence of general obesity was 65,4% in men and 68,5% in women. Abdominal obesity was found in 58,5% of men and 76.1% of women. By ROC-analysis we revealed the obesity-related markers with the best diagnostic accuracy for elevated/high cardiovascular risk assessed by the Systematic Coronary Risk Evaluation, Framingham Heart Study and Atherosclerotic Cardiovascular Disease risk algorithms. For men they were waist circumference waist-to-height ratio, for women — the body fat percentage. The optimal cut off values for these predictors and corresponding odds ratios for risk increase were determined.

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Key words: obesity, cardiovascular risk, Mongolians, bioelectrical impedance, waist-to-height ratio.

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AO — abdominal obesity, ASCVD — atherosclerotic cardiovascular disease, AUC — area under curve, BMI — body mass index, BP — blood pressure, CI — confidential interval, CV — cardiovascular, CVD — cardiovascular diseases, FRS — Framingham risk score, IR — interquartile range, Me — median, ROC — receiver operating characteristics, SCORE — Systematic Coronary Risk Evaluation, WC — waist circumference, WHp-R — waist-to-hip ratio, WHt-R — waist-to-height ratio.

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ПРОГНОСТИЧЕСКОЕ ЗНАЧЕНИЕ РАЗЛИЧНЫХ МАРКЕРОВ ОЖИРЕНИЯ ДЛЯ ОЦЕНКИ РИСКА СЕРДЕЧНО-СОСУДИСТЫХ ЗАБОЛЕВАНИЙ У РАБОТАЮЩИХ МОНГОЛОВ В ГОРОДСКОЙ СРЕДЕ

Protasov K. V. [1], Myagmarsuren T.[2]

Мы оценили распространенность ожирения и выявили маркеры, связанные с ожирением и повышенным/высоким риском сердечно-сосудистых заболеваний среди работающих монголов в городской среде. 1277 железнодорожников в возрасте 18-63 были обследованы. Были измерены параметры ожирения, артериального давления, уровни липидов и глюкозы плазмы крови натощак. Оценивали строение тела методом биоэлектрического импеданса. 10-летний риск сердечно-сосудистых событий был рассчитана. Результаты показали, что распространенность ожирения была у 65,4% мужчин и у 68,5% женщин. Абдоминальное ожирение найдено у 58,5% мужчин и у 76,1% женщин. С помощью ROC-анализа мы выявили ожирение-связанные маркеры с лучшей диагностической точностью для повышенного/высокого сердечно-сосудистого риска, оцениваемого SCORE, Фремингемским исследованием и шкалой ASCVD. Для мужчин это было отношение окружности талии к росту, для женщин — процент жира в организме. Были определены оптимальные значения этих предикторов и соответствующий показатель отношения шансов для роста рисков.

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Ключевые слова: ожирение, сердечно-сосудистый риск, монголы, биоэлектрический импеданс, отношение окружности талии и роста.

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Obesity presents one of the most acute medical and social problems in most countries of the world. Obesity revealing and relationships of its forms vary in different populations, the main reasons for that being ethnicity, differences in dietary patterns, the volume of physical activity, urbanization degree and profession. Obesity contributes immensely into the total risk of cardiovascular (CV) morbidity and mortality. Various obesity forms are differently related to CV risk. Specifically, waist circumference (WC) is of greater prognostic significance than the body mass index (BMI) [1]. However, in various populations the character of relationships between obesity parameters and CV risk has essential variations. So, in Asia as compared to European countries, the CV morbidity growth is associated with lower BMI [2]. This fact points out the need for distinguishing in different ethnic groups obesity markers most informative in CV risk assessment. In Mongolians obesity and overweight prevalence is scantily known while among employed population and railway employees in particular, it remains obscure. Obesity relationships with the degree of CV risk have not been studied yet. All these dictated the objective of the research as to assess the prevalence of obesity and identify obesity-related markers of elevated CV risk among urban employed Mongolians.

Material and methods

1277 Ulaanbaatar Railway employees (737 male and 540 female) were investigated. All participants were informed about the aim, character, methods and possible consequences of the research and gave the informed consent for the study. The study protocol was approved by the local ethic committee of Irkutsk State Medical Academy of Continuing Education. From all the subjects under study anthropometric and blood pressure (BP) measurements were taken; lipids and fasting plasma glucose levels were determined by conventional methods. BMI was derived by the formula: weight in kg/height^2 in meters. Obesity was diagnosed by Western Pacific Region (WPRO) criteria for Asians. At BMI from 23,0 to 24,9 kg/м^2 the body mass was considered overweight. Obesity I was diagnosed for BMI between 25-29,9 kg/m^2 and obesity II at BMI ≥30 kg/m^2. Abdominal obesity (AO) was diagnosed for WC ≥90 cm in men and ≥80 cm in women. Waist-to-hip (WHp-R) and waist-to-height (WHt-R) ratios were calculated. The body and visceral fat percentage were evaluated by bioelectrical impedance analysis with the use of the body composition monitor Omron KaradaScan HBF-361 ("Omron", Japan). Histories of smoking, diabetes and established CV diseases (CVD) were taken into account. The prevalence of obesity and overweight were determined in the study sample.

We calculated the risk of CVD events by three scales. A 10-year risk for fatal CVD events by the SCORE (Systematic Coronary Risk Evaluation) algorithm for high risk regions was assessed in 668 persons (326 men and 342 women) after having excluded patients with diabetes (n=40), fasting glucose level ≥7,0 mmol/l (n=63), previous myocardial infarction (n=11), angina pectoris (n=62), systolic BP >180 mmHg (n=37) as well as persons younger 40 (n=396). By SCORE<1% the CV risk was considered low, in the range from 1 to 4% — moderate, and at ≥5% — high/very high. A 10-year CVD events risk according to Framingham risk score (FRS) was calculated in 1095 persons, 602 males and 493 females, aged 30 and older without established CVD. By FHS<10% the CV risk was considered low, at the values from10 to 19% — moderate, and at ≥20% -high. A 10-year risk for a first hard atherosclerotic CV disease (ASCVD) event was also assessed by means of 2013 ACC/AHA risk calculator in 763 persons (385 men and 378 women) aged 40 and over without previous myocardial infarction and angina pectoris. The risk was stated as elevated at the value of ≥7,5%.

The diagnostic accuracy of each obesity marker for increased CV risk was evaluated through receiver operating characteristics (ROC) analysis. The areas under curve (AUC ± standard error) were used to identify the obesity index with the best classification properties. The optimal cut-off values were detected as the point at which the value of "sensitivity + specificity — 1" was maximum [3]. The odds ratios (OR) of the CV risk increase were calculated by univariate logistic regression analysis. Data analysis was done by Statistica 8.0 analysis software ("Statsoft", USA) and SPSS Statistics 19.0 ("IBM", USA). Mean values are expressed as median (Me) and interquartile range (IR). The sign prevalence in the sample was displayed by% and 95% confidential interval (CI). As distribution of variables was different from normal the Mann-Whitney *U* test was used to assess the differences. We applied *Chi*-square test for evaluating the relative values differences. *P*-value of less than 0.05 was used to assess the significance.

Results

A total of 1277 people (737 men and 540 women aged from 18 to 63) were enrolled in the study. The mean age was 42,0 (34-48) years, 40,0 (32-46) in men and 44,0 (38-49) in women (p<0,001). The prevalence of obesity and overweight is given in Table 1.

As can be seen from Table 1 the obesity prevalence by BMI according to WPRO criteria in Mongolian railway employees was rather high and amounted to 65,4% in men and 68,5% in women.

We determined the 10-year CVD events risk by three scales — SCORE, FRS and ASCVD among Mongolian urbanized employed population (Table 2).

The ROC-analysis results are presented in Table 3. Because the number of women at high CV risk was not

Table 1

The obesity prevalence and severity

Obesity marker	Men		Women	
BMI, kg/m^2, Me (IR)	27,3	(23,9-30,7)	27,2	(24,1-30,8)
BMI 23,0 to 24,9 kg/м^2,% (CI)	16,0	(13,2-18,8)	13,7	(10,6-16,8)
BMI 25,0 to 29,9 kg/м^2,% (CI)	36,0	(32,4-39,6)	38,1	(33,9-42,4)
BMI ≥30,0 kg/м^2,% (CI)	29,4	(26,0-32,9)	30,4	(26,3-34,4)
Waist circumference, cm, Me (IR)	92,0	(83,0-101,0)	89,0	(80,0-98,0)*
Abdominal obesity,% (CI)	58,5	(54,8-62,2)	76,1	(72,3-79,9)$^{\#}$
Waist-to-hip ratio, Me (IR)	1,0	(0,9-1,0)	0,9	(0,9-1,0)*
Waist-to-height ratio, Me (IR)	0,58	(0,54-0,61)	0,62	(0,57-0,65)*
Body fat,%, Me (IR)	27,0	(22,4-31,6)	35,5	(31,4-39,4)*
Visceral fat,%, Me (IR)	12,5	(8,5-18,0)	9,5	(6,0-14,5)*

* — p Mann-Whitney<0,001; † — pχ^2<0,001.

Abbreviation: BMI — body mass index.

Table 2

The estimated CV risk in employed urbanized Mongolians

Risk scale	Men		Women	
SCORE,%, Me (IR)	3,0	(2,0-4,0)	0,0	(0,0-1,0)*
SCORE 0-1%,% (CI)	3,4	(1,1-5,6)	52,1	(46,5-57,6)#
SCORE 1-4%,% (CI)	71,5	(66,3-76,7)	46,8	(41,2-52,4)#
SCORE ≥5%,% (CI)	25,2	(20,1-30,2)	1,2	(0,0-2,6)#
FHS,%, Me (IR)	6,0	(3,4-10,9)	2,9	(1,7-5,5)*
FHS <10%,% (CI)	71,6	(68,8-75,4)	90,5	(87,7-93,3)#
FHS 10-19%,% (CI)	19,4	(16,1-22,8)	7,3	(4,8-9,8)#
FHS ≥20%,% (CI)	9,0	(6,5-11,4)	2,2	(0,7-3,7)#
ASCVD,%, Me (IR)	3,3	(1,7-6,4)	1,0	(0,5-1,9)*
ASCVD≥7,5%,% (CI)	19,0	(14,8-23,1)	1,6	(0,1-3,1)#

* — p Mann-Whitney<0,001; † — pχ^2<0,001.

Abbreviations: SCORE — Systematic Coronary Risk Evaluation, FRS — Framingham risk score, ASCVD — risk for a first hard atherosclerotic CV disease.

Table 3

Diagnostic accuracy of obesity parameters for elevated/high CV risk (areas under curves)

Obesity marker	Risk scale				
	SCORE ≥1% women	SCORE≥5% men	FHS ≥10% women	FHS ≥20% men	ASCVD≥7.5% men
BMI, kg/m^2	0,592±0,03	0,606±0,04	0,651±0,04	0,558±0,04	0,554±0,04*
WC, cm	0,579±0,03*	0,593±0,04	0,686±0,04	0,646±0,04	0,655±0,04
WHp-R	0,502±0,03*	0,542±0,04*	0,637±0,05*	0,615±0,04	0,623±0,04
WHt-R	0,606±0,03	0,630±0,04	0,643±0,05*	0,608±0,04	0,601±0,04
Body fat,%	0,658±0,03	0,58±0,04	0,745±0,04	0,601±0,04	0,579±0,04
Visceral fat,%	0,632±0,03	0,607±0,04	0,703±0,04	0,591±0,04	0,581±0,04

* — p<0,05 for differences between the largest and given AUC.

Abbreviations: BMI — body mass index, WC — waist circumference, WHp-R — waist-to-hip ratio, WHt-R — waist-to-height ratio.

enough for correct estimation, calculations were performed in men at high risk by SCORE≥5%, FRS≥20% and ASCVD≥7,5%, and in women at moderate risk by SCORE≥1%, FRS≥20% и ASCVD≥7,5%.

For obesity markers with the largest AUC we determined cut-off values at which the optimal ratio of sensitivity and specificity is obtained. Odds ratios of CV risk increase in patients with obesity indices exceeding identified thresholds were calculated (Figure 1). Thus we defined the obesity markers of the highest accuracy for the increased CV risk prediction.

Discussion

We found a high prevalence of obesity in working urban Mongolians, as we have previously reported [4]. According to other authors overweight and obesity are more common in Mongols than in other Asian populations. Thus, among employed Japanese obesity by BMI ≥30 kg/m^2 was revealed only in 1,9% of men and 2,6% of women, and among Koreans — in 4,3% and 4,0%, respectively [5]. In the adult urban population of China the prevalence of AO was also rather small — in 42,6% of men and 45,7% of women [6]. These differences can be explained by traditional dietary habits of Mongolians, which differ in high amounts of high caloric meat products, saturated fats, oils, whole milk and sweets in daily diet. In addition, since the 1990s Mongolia has experienced a rapid urban population growth and significant changes in diet towards increased consumption of potatoes, refined grains, desserts, while sticking to the main part of meat and dairy products. Alcohol consumption has considerably increased along with the decline in physical activity. It is obviously these processes that can be related to the increased prevalence of obesity in Mongols in recent years.

However the above reasons do not account for the discrepancy between the data for obesity prevalence received from our research and those reported earlier in relation to the Mongolian population. So, in adult Mongolians BMI in the range of 25.0-29.9 kg/m^2 was reported in 31-36% of cases while BMI ≥30 kg/m^2 — in 7-24% [7], which is less common in comparison to the data received from our study sample. The revealed AO prevalence in our study was also found higher than that of the research by D. Otgontuya (2009), who reported it to be 46,1% in men and 65,1% in women of Mongolia. This discrepancy may be ascribed to the professional factor impact. The railway employees' professional activity is known to be characterized by psycho-

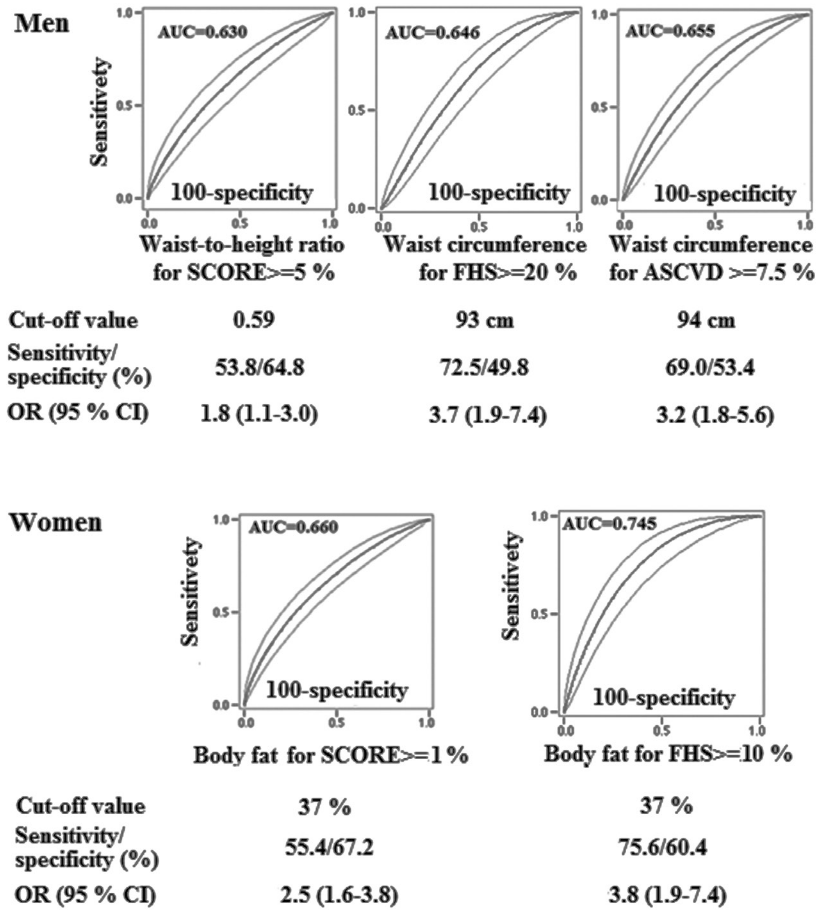

Figure 1. ROC-curves, areas under curve, cut-off values, odds ratios and sensitivity/specificity indices of the most informative obesity markers for elevated/high CV risk.

emotional overload, night shift work, increased levels of noise and vibration. These can result in chronic professional stress, which is, in its turn, an obesity risk factor [8, 9]. Overweight is also linked to the fact that railway employees usually live in cities taking up a “westernized” mode of life. This considerably changes a dietary pattern, widens the range of harmful habits, diminishes physical activity.

So, the combination of traditional food patterns, urbanization and professional factors is likely to result in such a high degree of obesity prevalence reported for our study sample. To answer the question whether this fact is associated with CV risk among the Mongols we pioneered in calculating 10-year CV event risk among the employed urbanized Mongolian population on three different scales — SCORE, FHS and ASCVD. It turned out that the risk mean value in men as well as the proportion of individuals with high risk was higher than in women for any of the scales. Noteworthy is the fact that most of men aged 40 years and older were found at high and very high CV risk. These data are confirmed by the work of other authors who stated the risk from SCORE≥5% and PROCAM≥20% in the locomotive crew to be 16% and 25% respectively, which is more frequent than that in individuals under low occupational stress [10]. According to the Framingham scale, the proportion of patients with high risk (≥20%) was relatively small which can be explained by younger average age of the given study sample — patients from 30 years old. It should be noted that the predictive accuracy of the scales we used for the Mongolian population was assessed earlier only for risk on the Framingham scale. According to the data received the current 10-year risk among residents of Inner Mongolia (China) amounted to 8,5% and was lower than the observed CC event frequency (13,4%) [11].

In this study we have determined which of the obesity parameters best predict the rise in CV risk. We emphasize that none of the markers for obesity was used at the stage of calculating the risk. The most informative indices for identifying high CV risk among the male population of Mongolia turned to be WHt-R (for SCORE≥5%) and WC (for FHS≥20% and ASCVD≥7,5%). Thus, the risk of CV events in men was associated with AO. The maximum area under the ROC curve is marked for a new system of risk prediction ASCVD, developed by the American College of Cardiology/American Heart Association (2013), which indirectly proves the applicability of this scale in male Mongols.

It is significant that calculated in our study the cut-off (threshold) values of WC as a factor of high CV risk were 93-94 cm, which are higher than the WPRO criteria for Asians (>90 cm) and almost the same as AO criterion for male Europeans (>94 cm) [12]. This, apparently, is not accidental: according to other studies the Mongols are more in line with the overweight criterion for WHO (BMI≥25,0 kg/m^2), than WPRO criterion for Asians (BMI≥23,0 kg/m^2) [13]. The WHt-R index in Mongol males was found to have the greatest prediction relevance by SCORE in comparison with the traditional BMI and WHp-R. Our data confirm the results of the recently published works, which reveal a better ability of WHt-R to predict the CC events [14].

Unlike men, among employed Mongolian women the total body fat index according to bioimpedance analysis was found to offer the most predictive efficiency. Clinical significance of body composition has in recent years actively investigated. However, rare studies are devoted to interrelation of body composition and CV risk [15]. According to our data the total fat content ≥37% increases by 2,5 to 3,8 times the development of elevated CV risk in women for European and Framingham scales, respectively. This fact justifies the possibility of easy and affordable bioimpedance method in assessing the CV risk in women.

Conclusion

We revealed a high prevalence of obesity among the Mongolian urbanized employed population. There was a significant proportion of men at a high cardiovascular risk, estimated by SCORE (25,2%), Framingham Risk Score (9,0%) and AHA/ACC 2013 Atherosclerotic Cardiovascular Disease risk (19,0%) algorithms. In men according to the ROC-analysis results the following abdominal obesity markers closely associated with high cardiovascular risk were: the waist-to-height ratio and the waist circumference. In women the whole body fat percentage evaluated by bioelectrical impedance analysis proved to be the best predictor for increased risk of cardiovascular events. In men the cardiovascular risk significantly rises with the waist circumference ≥93 cm and the waist-to-height ratio ≥0.59. In women it increases with the body fat volume ≥37%. Prognostic power of conventional obesity parameters such as body mass index and waist-to-hip ratio appeared to be insufficient for the effective cardiovascular risk screening in Mongolians.

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METABOLIC SYNDROME IN A MONGOLIAN WORKING POPULATION

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Aim. In this study we evaluated the metabolic syndrome (MetS) prevalence and its structure in Mongolian urban employed population.
Material and methods. The prevalence of MetS, defined by IDF (2005), JIS (2009) and modified NCEP ATP III (2004) criteria, was estimated in 1277 Mongolian railway workers (737 men and 540 women) aged 18 years or older.
Results. The MetS prevalence by IDF (2005) definition was found to be 36,1% in men and 39,6% in women, by JIS (2009) — in 38,9% and 40,9% and by NCEP ATP III (2004) — in 25,1% and 35,0% respectively. Abdominal obesity was the most common component (58,5% in men and 76,1% in women) as well as a constellation of abdominal obesity, elevated blood pressure and high serum triglycerides was the most common variant in MetS structure (51,9% in men and 30,4% in women).
Conclusion. Mongolian railway employees were characterized by high rate of MetS, which can be accounted for professional stress and changes in the lifestyle due to urbanization. The highest common components of MetS were found to be abdominal obesity, hypertension and hypertriglyceridemia.

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AO — abdominal obesity, ASCVD — atherosclerotic cardiovascular disease, AUC — area under curve, BMI — body mass index, BP — blood pressure, CI — confidential interval, DM2 — type 2 diabetes mellitus, FG — fasting plasma glucose, HDL-C — high-density lipoprotein cholesterol, HTN — arterial hypertension, LDL-C — low-density lipoprotein cholesterol, M — mean, MetS — metabolic syndrome, SD — standard deviation, TG — triglycerides, WC — waist circumference.

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МЕТАБОЛИЧЕСКИЙ СИНДРОМ СРЕДИ МОНГОЛЬСКОГО РАБОТАЮЩЕГО НАСЕЛЕНИЯ

Myagmarsuren T,[1] Protasov K. V.[2]

Цель. В данном исследовании мы оценивали метаболического синдрома (МС) распространенность и структура монгольского городского занятого населения.
Материал и методы. Распространенность МС, определяемая критериями IDF (2005), JIS (2009) and modified NCEP ATP III (2004), оценивалась у 1277 монгольских железнодорожников (737 мужчин и 540 женщин) в возрасте от 18 лет и старше.
Результаты. Распространенность МС по IDF (2005) была признана у 36,1% у мужчин и 39,6% женщин, по стандарту JIS (2009) — в 38,9% и 40,9%, и по modified NCEP ATP III (2004), соответственно. Абдоминальное ожирение является наиболее распространенным компонентом (58,5% у мужчин и 76,1% женщин), а также сочетание абдоминального ожирения, повышенного артериального давления и высокого уровня триглицеридов сыворотки было самым распространенным вариантом при МС (51,9% мужчин и 30,4% у женщин).
Заключение. Для монгольских железнодорожников характерен более высокий темп развития МС, который может быть следствием профессионального стресса и изменения образа жизни в связи с урбанизацией. Самыми распространенными компонентами МС оказались абдоминальное ожирение, артериальная гипертензия и гипертриглицеридемия.

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Ключевые слова: метаболический синдром, центральное ожирение, дислипидемия, артериальная гипертензия.

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Metabolic syndrome (MetS) is a clustering of abdominal obesity (AO), arterial hypertension (HTN), dyslipidemia and impaired carbohydrate metabolism. Clinical and prognostic significance of MetS as it is the expediency of its scientific consideration have lately become the subject of considerable discussion. Still it is common knowledge that on the one hand, the combination of risk factors mentioned above is not incidental, and on the other — it significantly increases the risk for type 2 diabetes mellitus (DM2) and cardiovascular diseases.

The MetS prevalence varies considerably in different populations and depends for the most part on the diagnostic criteria employed. In some ethnic groups, Mongolians in particular, the syndrome prevalence is scantily known, whereas among the urban employed population it remains obscure. Professional activity of the railway workers is characterized by a high psycho-emotional tension. Furthermore, most of them living in cities acquire "western" lifestyle. It is still unclear whether these factors affect the frequency of cardiometabolic risk factors resulting in MetS in Mongolians. Lastly, there are no studies on variants and ethnic character of correlations between different MetS components in Mongolians compared to other populations. In connection with the above the aim of our work was to study the MetS prevalence and its structure in Mongolian urban employed population.

Materials and methods

The study subjects were the Ulaanbaatar Railway employees, both male and female, residents of seven cities of Mongolia working at six Transmongolian Railway stations (Sükhbaatar, Darkhan, Dzüünharaa, Ulaanbaatar,

Table 1

Anthropometric and clinical characteristics of the study group

Parameter	Whole group n=1277		Men n=737		Women n=540		P-value*
	Mean (SD)		Mean (SD)		Mean (SD)		
Age, years	41,0	(9,2)	39,6	(9,4)	42,9	(8,6)	<0,01
WC, cm	91,0	(12,8)	92,2	(12,4)	89,3	(13,3)	<0,01
BMI, kg/m^2	27,6	(4,9)	27,5	(4,6)	27,9	(5,2)	0,42
Pack/years index	1,6	(4,6)	2,6	(5,7)	0,3	(1,4)	<0,01
TC, mmol/l	4,7	(0,8)	4,7	(0,7)	4,7	(0,8)	0,16
LDL-C, mmol/l	2,4	(0,6)	2,4	(0,6)	2,4	(0,7)	0,77
HDL-C, mmol/l	1,5	(0,3)	1,5	(0,3)	1,5	(0,3)	0,06
TG, mmol/l	1,7	(0,6)	1,7	(0,6)	1,6	(0,6)	<0,01
FG, mmol/l	5,2	(1,9)	5,3	(2,0)	5,1	(1,9)	<0,01
SBP, mmHg	127,4	(20,2)	129,7	(19,0)	124,3	(21,4)	<0,01
DBP, mmHg	81,4	(11,5)	82,5	(10,2)	80,0	(13,0)	<0,01

* — for the differences between male and female groups

Abbreviations: WC — waist circumference, BMI — body mass index, TC — total cholesterol,LDL-C — low-density lipoprotein cholesterol, HDL-C — high-density lipoprotein cholesterol, TG — triglycerides, FG — fasting glucose, SBP and DBP — systolic and diastolic BP.

Choir, Sainshand and Zamyn-Üüd). Altogether 1500 questionnaires were sent. The response rate totaled 85,1% (1277 persons, 737 male and 540 female). The dominant ethnicity reported was Mongolians (96,1%). All patients were informed about the aim, character, methods and possible consequences of the research and gave the informed consent for the study. The study protocol was approved by the local ethic committee of Irkutsk State Medical Academy of Continuing Education.

Weight and height were measured with calibrated digital weighing scales and a height bar. The waist circumference (WC) was measured with measurement tape horizontally after a number of successive breaths at the point midway between the iliac crest and the costal margin (lower rib). Measurements were taken by trained nurses. AO was diagnosed by two criteria: $AO_{80\text{-}90}$ — for Asian residents with WC ≥80 cm in women and ≥90 cm in men [1], $AO_{88\text{-}102}$ — with WC≥88 cm in women and ≥102cm in men by criteria NCEP ATP III [2]. BMI was derived following the formula: weight in kg/height^2 in meters.

Blood pressure (BP) was measured thrice with a two minute interval on the right hand of a sitting patient after a five minute rest. The mean of the three measurements was calculated. HTN as a criterion for MetS was diagnosed at systolic BP ≥130 mmHg and/or diastolic BP ≥85 mmHg. Subjects who claimed to have previously diagnosed hypertension and taking antihypertensive drugs were referred to as HTN patients.

The lipid and fasting plasma glucose (FG) concentration was measured at the laboratory of the Ulaanbaatar railway company hospital. Total cholesterol, triglycerides (TG) and high-density lipoprotein cholesterol (HDL-C) were measured by colorimetric method with a Humalyser 3000 autoanalyzer system ("Human", Germany). Venous blood was collected from the antecubital vein after a 12-h overnight fast. Low-density lipoprotein cholesterol (LDL-C) was calculated by the following formula: LDL-C (mmol/L) = total cholesterol (mmol/L) — TG (mmol/L) / 2,2 — HDL-C (mmol/L). History of DM2 was taken into account. The data were collected from September 2011 till June 2012.

MetS was diagnosed according to the IDF (2005), JIS (2009) and modified NCEP ATP III criteria, as we have previously reported [3]. The IDF criteria included $AO_{80\text{-}90}$ in combination with at least two of the following indicators — TG≥1,7 mmol/L, HDL-C<1,0 mmol/L in men and <1,3 mmol/L in women or lipid lowering therapy, BP ≥130/85 mmHg or antihypertensive medication, FG ≥5,6 mmol/L or DM2 [4]. According to the Joint Interim Statement criteria (JIS, 2009) any three or more of the following five components were taken into account: $AO_{80\text{-}90}$, TG≥1,7 mmol/L, HDL-C<1,0 mmol/L in men and <1,3 mmol/L in women, BP ≥130/85 mmHg or antihypertensive medication, FG ≥5.6 mmol/L or glucose-lowering therapy [5]. MetS diagnosis by NCEP ATP III (2004) was carried out in the same way as by JIS (2009), though instead of $AO_{80\text{-}90}$ criterion we used $AO_{88\text{-}102}$ [1, 2].

Data analysis was done by Statistica 8.0 analysis software («Statsoft», USA). The character of distribution was determined by Kolmogorov-Smirnov and Lilliefors normality tests. Mean values are expressed as mean (M) and standard deviation (SD).The sign prevalence in sample was displayed by% and 95% confidential interval (CI). As distribution of variables was different from normal the Mann-Whitney U test was used to assess the differences. We applied Chi-square test and crosstabulation tables for evaluating the relative values differences. P-value of less than 0.05 was used to assess the significance.

Table 2

Prevalence of MetS criteria

MetS criterion	Whole group n=1277		Men n=737		Women n=540		*P*-value*
	%	95% CI	%	95% CI	%	95% CI	
AO_{80-90}	65,9	(63,3-68,6)	58,5	(54,8-62,2)	76,1	(72,3-79,9)	<0,01
AO_{102-88}	35,9	(33,2-38,7)	23,7	(20,5-27,0)	52,6	(48,2-7,0)	<0,01
LDL-C ≥3.0 mmol/L	15,7	(13,6-17,7)	14,8	(12,1-17,5)	16,9	(13,5-20,2)	0,32
↓HDL-C	11,5	(9,7-13,3)	1,1	(0,2-2,0)	25,7	(21,9-29,6)	<0,01
TG ≥1.7 mmol/L	50,8	(48,0-53,6)	53,6	(49,9-57,3)	47,0	(42,6-51,4)	0,02
$\uparrow FG_{5.6}$	24,6	(22,1-27,0)	27,8	(24,4-31,2)	20,2	(16,6-23,8)	<0,01
DM2 or FG≥7.0 mmol/L	8,1	(6,5-9,6)	9,6	(7,4-11,9)	5,9	(3,7-8,1)	0,02
BP ≥130/85 mmHg or HTN therapy	57,2	(54,4-60,0)	61,2	(57,5-64,9)	51,9	(47,4-56,3)	<0,01

* — for the differences between male and female groups

Abbreviations: AO, abdominal obesity; TC, total cholesterol; LDL-C, low-density lipoprotein cholesterol; HDL-C, and high-density lipoprotein cholesterol; ↓HDL-C, HDL-C<1.0mmol/L in men and <1.3mmol/L in women; TG, triglycerides; $\uparrow FG_{5.6}$, plasma fasting glucose ≥5.6 mmol/L; DM2, diabetes mellitus type 2; BP, blood pressure; HTN, hypertension.

Table 3

MetS prevalence among working urbanized population of Mongolia

MetS definition	Whole group n=1277		Men n=737		Women n=540	
IDF,% [95% CI]	37,6	[34,9-40,3]	36,1	[32,5-39,7]	39,6	[35,3-43,9]
JIS,% [95% CI]	39,8	[37,0-42,5]	38,9	[35,3-42,6]	40,9	[36,6-45,3]
NCEP ATP III,% [95% CI]	29,3	[26,7-31,9]†§	25,1	[21,8-28,4]†§	35,0	[30,8-39,2]*
Mean number of MetS criteria by IDF or JIS (SD)	2,1	(1,2)	2,0	(1,2)	2,2	(1,2)*
Mean number of MetS criteria by NCEP ATP III (SD)	1,8	(1,2)	1,7	(1,2)	2,0	(1,2)*

* — p<0,05 for the differences between male and female groups, † — p<0,05 for the differences between MetS prevalence by IDF and NCEP ATP III, § — p<0,05 for the differences between MetS prevalence by JIS and NCEP ATP III.

Abbreviation: MetS — metabolic syndrome.

Results

Table 1 presents anthropometric and clinical characteristics of patients under study. Men were younger than women. They smoked more and have higher WC, TG and BP values.

As it follows from Table 2 the most frequently defined criteria of MetS were AO, HTN and high TG. Men differed from women by elevated TG and FG, DM2 and HTN prevalence values. AO and low HDL-C were found more frequently in women. AO by IDF criteria for Asian residents occurred more regularly than by NCEP ATP III criteria.

The MetS prevalence by the IDF (2005), JIS (2009) and NCEP ATP III (2004) criteria is given in Table 3.

As can be seen from Table 3, the MetS prevalence by IDF (2005) and JIS (2009) with the use of AO criteria for Asian population did not differ and was the same in men and women. The MetS prevalence by NCEP ATP III (2004) with the use of "mild" definitions was found to be less regular for the group on the whole and for men and women as well. At the same time the average number of MetS criteria was regularly higher in women than in men.

The MetS prevalence increased with age both in men and women (Table 4).

The presence of three diagnostic criteria in the structure of MetS prevailed, whereas the combination of all five components was found extremely rare and mostly in women (Figure 1).

The most regular combination of the MetS components was found to be the combination of AO, HTN and high TG both in men and women (prevailing in men; *P*<0,001). The second most frequent variant was the combination of the three above symptoms with hyperglycemia (prevailing in men; *P*<0,001). The third leading MetS variant was proved to be the combination of AO, HTN and hyperglycemia in men and AO, HTN and low HDL-C in women. Different MetS variants including low HDL-C were found mostly in women (Figure 2).

Discussion

Asian population is known to be characterized by insulin resistance when having less body mass and waist circumference values and genetic predisposition to diabetes [6]. So, the study of the regional specific features of MetS and its timely diagnosing is considerably important for preventing DM2 and cardiovascular complications. The results of our study showed that the MetS prevalence among the Mongolian railway workers of both genders was

Table 4

MetS prevalence according to gender and age

MetS definition	18-29 years	30-39 years	40-49 years	≥50 years
	% [95% CI]	% [95% CI]	% [95% CI]	% (95% CI]
Men	n=135	n=216	n=272	n=114
IDF	14.8 [8.1-21.5]	36.6 [29.7-43.5]*	43.0 [36.8-49.3]	43.9 [33.9-53.8]*
JIS	14.8 [8.1-21.5]	40.7 [33.7-47.8]*	45.6 [39.3-51.9]	48.3 [38.2-58.3]*
NCEP ATP III	6.7 [1.7-11.6]*	27.3 [29.7-43.5]	29.4 [23.6-35.2]	32.4[23.0-41.9]*
Women	n=47	n=114	n=260	n=119
IDF	17.0 [4.2-29.9]	23.7 [15.0-32.4]	40.0 [33.7-46.3]	63.0 [53.5-72.5]
JIS	17.0 [4.2-29.9]	24.6 [15.8-33.3]	41.1 [34.8-47.5]	65.6 [56.2-74.9]
NCEP ATP III	17.0 [4.2-29.9]	21.0 [12.7-29.4]	35.8 [29.6-42.0]	53.8 [44.0-63.6]

* — p<0,05 for the differences between male and female groups.

high and by IDF (2005) amounted to 37,6%, and by JIS (2009) — to 39,8%. Minimal MetS occurrence (29,3%) was determined when using milder AO thresholds — 102 and 88 cm by NCEP ATP III (2004). There were reported only a few studies on the MetS prevalence in Mongolia. For instance, in a sample of 456 Mongolians MetS was diagnosed in 8-12% cases [7]. The given study included nomads and farmers living in rural regions of Inner Mongolia, People Republic of China. A similar result (12%) was obtained from the survey of 596 Japanese and Mongolians by NCEP ATP III criteria [8].

In our investigation the values for the MetS prevalence among Mongolians appear to be considerably higher than those presented above. This can be connected with the specificity of the study sample, which included urban employed residents. Urbanized lifestyle is liable to modify dietary patterns and reduce physical activity thus increasing the risk of abdominal obesity and MetS. Some of the supporting evidence for this comes from the data on the MetS frequency among urbanized Mongolian population. In a sample of 2536 adults after 20 years of age of Tongliao city, Inner Mongolia, the MetS prevalence amounted up to 17,1% and 19,6% by the IDF и NCEP ATP III criteria respectively [9]. A similar MetS frequency range — from 13,5% in women to 18,6% in men — was revealed among 257 industrial workers in Ulaanbaatar [10]. There is also evidence of higher MetS frequency among urban population in other regions of Asia. Besides, the effect of psycho-emotional stress the railway workers suffer in their professional activity on the development of MetS components must not be ruled out. Extremely high levels of obesity, dyslipidemia and hypertension among the engine railway drivers were reported by some authors [11].

The most close to our data values were reported by U. Shuumarjav (2011) according to which the MetS prevalence obtained from the sample of 285 Mongolian volunteers was 39,6% [12]. According to some authors the MetS frequency is higher in Mongolian than in Japanese (39,6% vs 31,1%), Chinese rural (37,6% vs 33,9%) and Korean (15,7% vs 7,8%) populations [9, 12, 13]. This fact

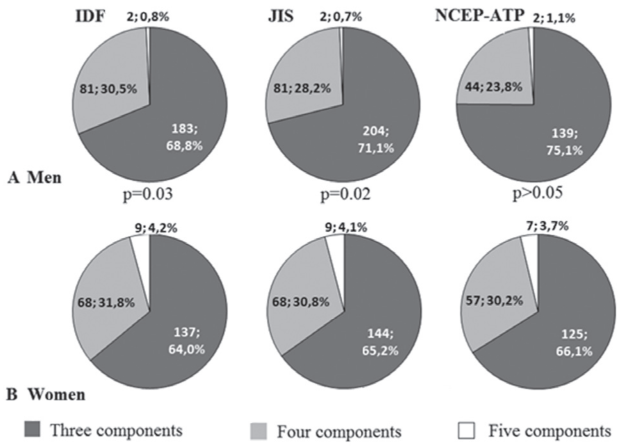

Figure 1. MetS variants related to the number of diagnostic criteria.

is explained by the higher prevalence of obesity and greater body fat percent in Mongolians due to urbanization and the attendant relatively unhealthy lifestyle [9]. In this connection it could be interesting to compare the MetS prevalence data on Mongolians with the records on Russian Siberia residents. The fullest MetS epidemiological data for Siberia were presented by G. I. Simonova (2011), according to which MetS frequency by the IDF criteria among 9190 residents of Novosibirsk city aged from 45 to 69 was 44,0% for both genders. This value was higher than we received (37,6%), however the above sample was population-based and differed by older age. Furthermore MetS significantly differed in structure and its components frequency. Hypertension, for instance, was more frequent in Russian Siberia Caucasians (75,0%) than in Mongolians (57,2%). Hyperglycemia frequency was also much higher in the Russians (54,8%) compared to that of the Mongolians (24,6%). Conversely, hypertriglyceridemia was found in a half of our study sample (50.8%), whereas among Russian Siberia residents it was only 28,8%. Besides, the MetS prevalence was higher in women of the Siberian population (52%) irrespective of diagnostic criteria, whereas in Mongolians it did not depend on gender when using AO definitions for Asia [14].

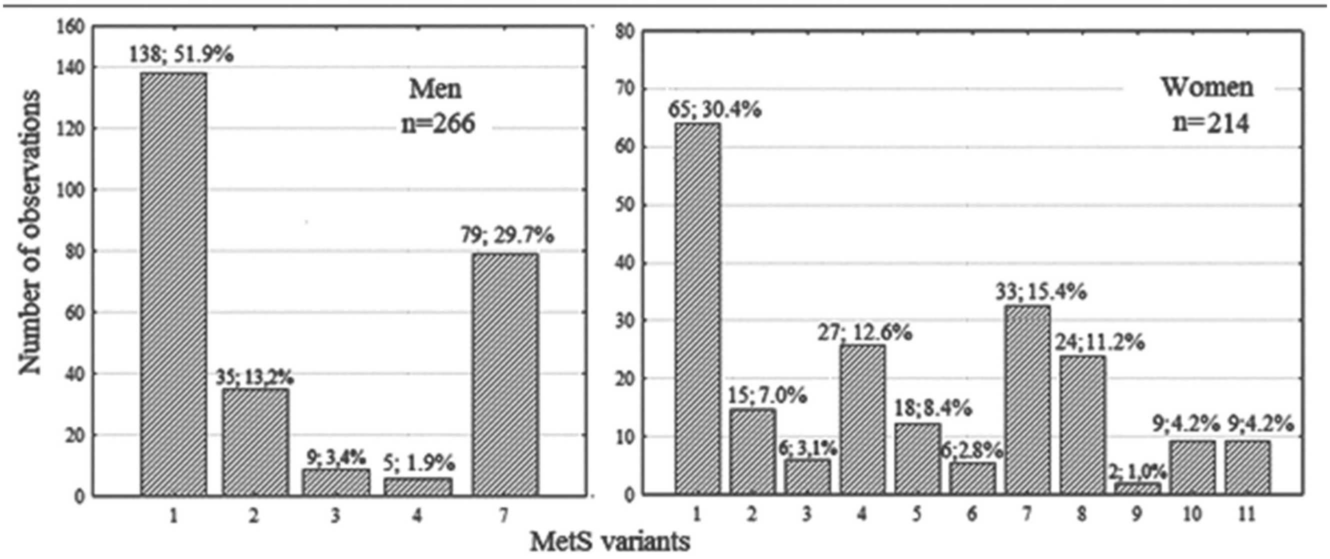

Figure 2. MetS variants by IDF criteria related to component combination.
The numbers on the horizontal axis denote the following variants of MetS: 1 — AO + HTN + high TG, 2 — AO + HTN + elevated FG, 3 — AO + high TG + elevated FG, 4 — AO + HTN + low HDL-C, 5 — AO + high TG + low HDL-C, 6 — AO + low HDL-C + elevated FG, 7 — AO + HTN + high TG + elevated FG, 8 — AO + HTN + high TG + low HDL-C, 9 — AO + high TG + low HDL-C + elevated FG, 10 — AO + HTN + low HDL-C + elevated FG, 11 — all five metabolic syndrome components.

For the residents of the European part of Russia (1561 employees of St. Petersburg) the most frequent combinations of the MetS structure were AO+HTN+low HDL-C and AO+HTN+elevated FG in contrast to our results in which these MetS variants ranked third and fifth in women and fifth and third in men [15]. In the West European population according to PAMELA study at total MetS prevalence by the NCEP ATP III criteria of 16,2% the most regular components were HTN (95,4%), high TG (77,1%) and low HDL-C (72,2%) [16], whereas in our study sample it was the combination of AO, HTN and high TG.

High prevalence of hypertriglyceridemia, which was revealed in a half of the studied subjects is seen to be another peculiarity of MetS. This fact may be explained by dietary habits of Mongolians who take large amounts of meat, milk, dairy products with high fat/total calorie ratio and saturated fatty acids proportion. And yet the main reason is likely to be a rapid growth of dietary carbohydrates consumption in Mongolian urban inhabitants leading to carbohydrate-induced hypertriglyceridemia.

Study strengths and limitations

It is the first report on the study of the MetS prevalence among Mongolian urbanized working population, railway workers in particular. We made an attempt to distinguish some important features of the MetS formation in Mongolian urban employees. Firstly, MetS prevalence was found to be considerably high, which can be connected to professional stress and changes in the lifestyles of city dwellers. Secondly, we proved hypertriglyceridemia along with AO and HTN to be the most regular components in the MetS structure, whereas low HDL-C and elevated FG are occasional.

The limitations of the study are as follows: (1) there was the cross-sectional design in which causality can't be determined; (2) the sample was not population-based and formed on the basis of directional selection although the study included the workers of all major railway stations in proportion to the staff number, and the study sample was formed with the account of the total number of employees, maximal expected MetS prevalence and admissible error.

Conclusion

The prevalence of MetS in Mongolian railway employees by the IDF (2005) criteria amounted to 36,1% in men and 39,6% in women, by JIS (2009) — 38,9% and 40,9%, by NCEP ATP III (2004) — 25,1% and 35,0%. The syndrome frequency increased with age reaching its maximal value at 50 years and after. No gender difference in the MetS prevalence by IDF and JIS criteria was observed despite the significant difference in the frequency of its separate components. The most frequent of the MetS criteria was abdominal obesity found in 58,5% of men and 76,1% of women, whereas the most frequent MetS variant was the combination of abdominal obesity, hypertension and hypertriglyceridemia observed in 51,9% of men and 30,4% of women.

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IMPLANTATION OF AN ICD AND DFT TESTING IN PATIENT WITH PERSISTENT LEFT *SUPERIOR VENA CAVA*

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Aim. The implantable cardioverter-defibrillator [ICD] has been proven to reduce the risk of sudden cardiac death through the termination of ventricular fibrillation and life-threatening ventricular tachycardia. The simplest measure of defibrillation effectiveness is the DFT, defined as the lowest delivered shock strength required to defibrillate. Improved technology and use of ICDs for primary prevention have led some to question the need for either defibrillation testing or any assessment of defibrillation efficacy after implantation. Experts disagree about optimal testing because data are insufficient to define the trade-off between accuracy and risk of testing. However there are specific cases in which DFT is necessary.

Material and methods. Authors describe the case of a patient with persistent left *vena cava*, a rare congenital anomaly, with no clinical importance which is usually accidentally revealed during the implantation of pacemaker or when placing a central vascular catheter. However, it represents a major problem and challenge for positioning of the standard pacemaker electrodes.

Results. After a successful implantation via unconventional anatomic path authors carried out DFT testing to check that the device is functioning appropriately.

Conclusion. Persistent left *vena cava* should not represent a contraindication for implantation of complex pacemaker systems such as ICD and DFT testing is advisable in this cases.

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ICD — implantable cardioverter defibrillator, DFT — defibrillation effectiveness testing, VF — ventricular fibrillation, VT — ventricular tachycardia, PLVCS — persistent left *superior vena cava,* VCS — *vena cava superior,* LVEF — Left ventricular ejection fraction, CRP — C-reactive protein, ESR — erythrocyte sedimentation rate, CRT — cardiac resynchronization therapy.

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ИМПЛАНТАЦИЯ ИКД И ТЕСТИРОВАНИЕ ДЕФИБРИЛЛЯТОРА У ПАЦИЕНТА С ПЕРСИСТИРУЮЩЕЙ ЛЕВОЙ ВЕРХНЕЙ ПОЛОЙ ВЕНОЙ

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Цель. Доказано, что имплантируемый кардиовертер-дефибриллятор (ИКД) уменьшает риск внезапной сердечной смерти, снижает частоту фибрилляции желудочков и опасной для жизни желудочковой тахикардии. Самой простой мерой оценки эффективности дефибрилляции является тестирование, определяющее наименьшую ударную силу, которая требуется, чтобы дефибриллировать. Совершенствование технологии и использование ИКД для первичной профилактики привели некоторых к сомнению в необходимости дефибрилляции, либо испытаний или оценки эффективности дефибрилляции после имплантации. Эксперты разошлись во мнениях об оптимальном тестировании, поскольку данных недостаточно, чтобы определить компромисс между точностью и риском тестирования. Однако существуют особые случаи, в которых тестирование необходимо.

Материал и методы. Авторы описывают случай пациента с персистирующей левой верхней полой вены, редкой врожденной аномалией, при отсутствии клинических данных, которые обычно случайно выявляются во время имплантации кардиостимулятора или при размещении центрального сосудистого катетера. Тем не менее, поражение представляет серьезную проблему и требует позиционирования стандартных электродов кардиостимулятора.

Результаты. После успешной имплантации через нетрадиционные анатомические пути авторами проведено тестирование, чтобы проверить, что устройство функционирует должным образом.

Заключение. Персистирующая левая полая вена не является противопоказанием для имплантации ИКД, в этом случае желательно тестирование.

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Ключевые слова: имплантация кардиовертера-дефибриллятора, дефибрилляция, порог тестирования, персистирующая левая верхняя полая вена.

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Introduction, materials and methods

The implantable cardioverter-defibrillator (ICD) has been proven to reduce the risk of sudden cardiac death through the termination of ventricular fibrillation (VF) and life-threatening ventricular tachycardia (VT). Defibrillation threshold (DFT) testing has traditionally been an integral component of ICD implantation [1]. Electrical shocks delivered by ICDs arise from the discharge of the capacitors through the heart via the high energy electrodes. The main determinant of success of defibrillation is the magnitude of the electric field generated across the heart. Although the magnitude may be very hard to determine because of its dependence on numerous factors, it is usually proportional to the spatial derivative of the voltage. The simplest measure of defibrillation effectiveness is the DFT, defined as the lowest delivered

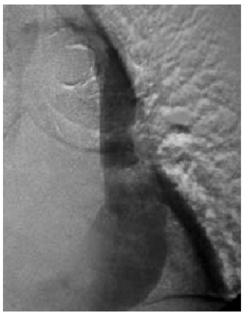

Figure 1. Venography showing the left caval vein.

shock strength required to defibrillate. The DFT is often determined in a step-down manner, in which shocks of progressively lower intensity are delivered, after VF is induced, and the lowest successful shock strength is defined as the DFT. The step down DFT is a convenient measurement to obtain during implantation and generally correlates with a probability of success of approximately 70%-80%. Historically, a safety margin (a margin between the DFT and the maximum output of the ICD) of 10 J was considered as a minimal implantation criteria. 30-35 J outputs are for most devices, and 20-25 J has been considered the maximum acceptable DFT [2].

Improved technology and use of ICDs for primary prevention have led some to question the need for either defibrillation testing or any assessment of defibrillation efficacy after ICD implantation. Experts disagree about optimal testing because data are insufficient to define the trade-off between accuracy and risk of testing. Overall, sensing and detection issues require induction of VF in about 5% of ICD recipients, testing defibrillation efficacy is required in 20% to 40%, and testing is contraindicated in about 5% because of conditions such as left atrial appendage thrombus, inadequate anesthesia, and inadequate external rescue support [2]. Currently, assessing defibrillation efficacy at implantation is the legal standard of practice and the recommendation of the Heart Rhythm Society [3]. Despite that DFT is not done routinely in majority of cases. Accordingly, findings from the large SIMPLE study demonstrate that those patients who received ICDs without defibrillation testing did as well as those who underwent the standard defibrillation testing at the time of implantation.

Defibrillation testing is typically performed at the completion of the implant procedure, often before or during closure of the ICD pocket. Number of defibrillation testing protocols has been used in the past. Presently it is more common to ensure a repeated successful defibrillation 10 J or more below the maximum output of the device or at least once 15–20 J or more below the maximum output of the device. This testing protocol does not determine the actual defibrillation threshold but does establish defibrillation efficacy [2, 3].

Persistent left *superior vena cava* (PLVCS) represents a rare congenital vascular defect of the venous system, and is usually discovered accidentally. In the early phase of embryogenesis, the venous system is bilateral — meaning that there are bilateral primitive venous vessels. An anomaly in this phase of embryogenesis is characterized by the existence of bilateral venous system. Usually, besides PLSVC, the right *vena cava superior* (VCS) is also present, with communication between them through the variable *vena inominata*, which can be absent in 70% of cases [4]. In 65% of patients, the right VCS is small in diameter [5]. The overall incidence of PLSVC is 0.3% to 0.5% in general population, 4% of which have other congenital defects [5, 6]. The incidence is similar in patients that need pacemaker therapy, and is 0.47% [7]. The presence of only PLVCS occurs in 1% of patients [8-10]. In relation to the way of the inflow of PLVCS in the heart, there are few anatomic variants:

• PLVCS flowing through the dilated coronary sinus into the right atrium, this variation occurs in over 90% of cases. It can be isolated or associated with other abnormalities of the cardiovascular system.

• Other variations include inflow of PLVCS in the left atrium in two ways:

— PLVCS empties into the coronary sinus, which has a defect in the wall and communicating with the left atrium;

— PLVCS flows directly into the roof of the left atrium between the left upper pulmonary vein and the left auricula. This anomaly is always associated with other heart anomalies [6, 7].

Case report

Patient M. B., male, 26 years old, was complaining of dyspnea, fatigue, swelling of the legs. Three months prior to admission he was treated in the regional hospital for infectious syndrome accompanied by symptoms of heart failure due to consequent myocarditis. Left ventricular ejection fraction (LVEF) was then 30%.

Patient was admitted to Clinical Centre Nis due to worsening of heart failure and malignant dysrhythmia on the ECG in the form of VT. Echocardiography showed a dilated left ventricle (63x51 mm) with LVEF of 28%. Routine laboratory parameters were in referent values, including erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP). Twenty-four hours ambulatory ECG monitoring showed frequent ventricular premature beats, individual, polymorphic, as well as ventricular couplets and VT. Since the patient had left bundle branch block, authors decided to implant an ICD device.

In local anesthesia, after puncture of the left subclavian vein operator placed the electrode of the ICD Medtronic Sprint Quattro 6947, 75 cm when the existence of the left persistent left *superior vena cava* was observed (Figure 1). The electrode was placed in the outflow tract of the right ventricle with good parameters of the installation (TR 1.1, R> 9mV, Imp 1075Ω) (Figure 2).

Then the patient was sedated by anesthesiologist and operator carried out the electrophysiology test of the DFT. Authors got DFT on 15 J, with the first successful defibrillation (Figure 3).

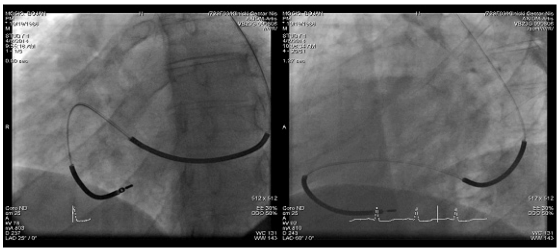

Figure 2. Placing the electrode in the outflow tract of the right ventricle through the persistent left caval vein.

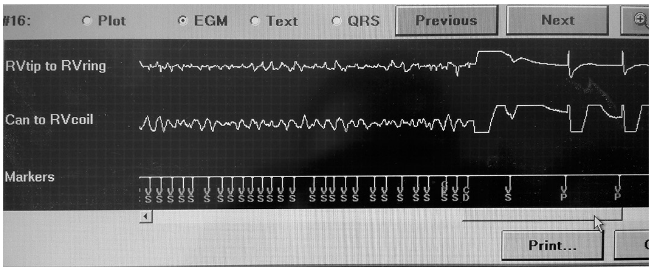

Figure 3. Succesful DFT testing with 15J.

It was decided that the electrode is successfully placed in the proper position despite inadequate anatomical path. The presence of the PLVCS did not represent a problem for the successful implantation of the ICD.

Patient gave the written informed consent. All work was done according to the Declarations of Helsinki and Tokyo, and Ethical Committee of the Clinical Centre Nis.

Discussion

Primary prevention of sudden cardiac death refers to patients with myocardial disease and impaired left ventricle with decreased LVEF. Several studies have demonstrated the benefit of an implanted ICD compared to medical therapy. Reduction in LVEF below 35% increases the incidence of malignant arrhythmias not in linear but in exponential manner, so below this threshold significantly higher occurrence of life-threatening rhythm disturbances is expected. MADIT study demonstrated reduction in mortality of 54% in patients with LVEF <35%, and an implanted ICD due to ischemic heart disease. MUSTT study which included patients with decreased LVEF <35% shown that in the group of patients with an ICD reduction in the mortality rate due to arrhythmia was 75% and overall reduction in mortality was 60%. SCD-HEFT study compared the effects of an ICD with antiarrhythmic drug-amiodarone. Patients with an ICD had reduced mortality by 23%. MADIT II study evaluated the benefit of prophylactic ICD implantation in patients with coronary artery disease and LVEF <30%. The patients with an ICD had a mortality reduction of 31% compared to a group of patients with a conventional therapy [11, 12]. That was the reason why authors decided to place an ICD pacemaker to theirs' patient.

PLVCS is a congenital anomaly with no clinical importance and is usually accidentally revealed during the implantation of electrodes of the temporary or permanent pacemaker or when placing a central vascular catheter, as in authors' patient. However, PLVCS is a major problem and challenge for positioning of the standard pacemaker electrodes. As an alternative to ventricular stimulation, pacing from the coronary sinus can be used since it is readily available in these patients [13]. A particular problem, and sometimes disabling factor, occurs in patients who have indicated ICD implantation or the electrodes of the CRT-P or CRT-D system [13-15]. This was not the case with authors' patient.

DFT testing in this case was done during implantation because of the presence of the anomaly, while the DFT test is not done routinely at Clinical Centre Nis. DFT in the right ventricular outflow tract did not differ in practice from DFT with ICD system where authors placed electrodes at the apex of the right ventricle.

Conclusion

The presence of persistent left *superior vena cava* is not contraindication for a successful implantation of complex pacemaker systems such as an ICD. Defibrillation testing is advisable during at or following ICD implantation to assure the physician that the device is functioning appropriately and that it will deliver needed therapy in the future.

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VECTOR ELECTROCARDIOGRAPHY IN THE DIAGNOSTICS OF FOCAL CHANGES IN THE MYOCARDIUM

Belaya I.Ye., Kolomiets V.I., Vislouh G.Ye.

Acute coronary disease diagnostics improvement is a worldwide priority. The introduction of a promising method of study of the electromotive force of the heart with the use of information technologies, allows us to diagnose acute myocardial infarction. We have used a modern cardiodiagnostics complex MTM-SKM by Severodonetsk Scientific Production Association "Microtherm" (Ukraine).

Clinical case. The presence of vectorcardiography necrobiotic processes in the left ventricle apical region, intraventricular conduction and hemodynamic overload of the atria has been revealed at the patient D., 59, with acute myocardial infarction, which was additional information that has not been registered on the ECG.

Conclusion. Vector electrocardiography, allows us to investigate the periodic distribution of the electromotive force in dynamics over the entire surface of the heart, and also makes it possible to obtain detailed information about the functional state of the myocardium, specifying the depth and extent of the pathological process.

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Key words: acute myocardial infarction, cardiodiagnostic complex MTM-SKM, vectorcardiography, thrombolytic therapy.

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ECG — electrocardiography, EMF/H — electromotive force of the heart, LV — left ventricle, MI — myocardial infarction, PCI — percutaneous coronary intervention, STEMI — ST elevation myocardial infarction.

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ВЕКТОРНАЯ ЭЛЕКТРОКАРДИОГРАФИЯ В ДИАГНОСТИКЕ ОЧАГОВЫХ ИЗМЕНЕНИЙ В МИОКАРДЕ

Белая И.Е., Коломиец В.И., Вислоух Г.Е.

Совершенствование диагностики острой коронарной патологии является приоритетной задачей во всем мире. Внедрение перспективного метода исследования электродвижущей силы сердца с использованием информационных технологий позволяет своевременно диагностировать острый инфаркт миокарда. Нами использован современный кардиодиагностический комплекс МТМ-СКМ Северодонецкого научно-производственного объединения "Микротерм" (Украина).

Клинический случай. Векторкардиографически выявлено наличие некробиотического процесса в верхушечной области левого желудочка, нарушение внутрижелудочковой проводимости и гемодинамическая перегрузка предсердий, что является дополнительной информацией, не зарегистрированной на ЭКГ.

Заключение. Векторная электрокардиография, позволяющая исследовать весь период распространения электродвижущей силы в динамике по всей поверхности сердца, дает возможность получить исчерпывающую информацию о функциональном состоянии миокарда с уточнением глубины и распространенности патологического процесса.

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Ключевые слова: острый инфаркт миокарда, кардиодиагностический комплекс МТМ-СКМ, векторкардиография, тромболитическая терапия.

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Introduction

Coronary heart disease is the most common cause of death in Europe, causing nearly 2 million deaths every year. Coronary artery pathology still cause death of approximately 17% of men aged 65 years and 12% of women of the same age [1]. In this regard, the introduction of new information technologies into acute coronary disease diagnostics is a priority in cardiology throughout the world, and the possibility to use the equipment at the bedside is an important component of a comprehensive diagnostic approach to patients. According to the Task Force of the European Society of Cardiology on the management of ST segment elevation myocardial infarction (MI) (2008), electrocardiography (ECG) plays a central role. However, in the case of questionable results of ECG, particularly in the early stages of a heart attack, it is necessary to conduct repeated ECG studies, electrotopogram registration, echocardiogram and evaluation of cardiac biomarkers levels with their ambiguous estimation due to their high sensitivity and low specificity [2]. Therefore, the use of innovative technologies will allow us to diagnose acute MI on time and with high accuracy.

A promising myocardial disease diagnostic method is vector ECG, which allows earlier detection of local changes in myocardial activity, provides more accurate diagnostics of focal myocardial changes regarding their location and extent. Also at heart attacks which are complicated by bundle-branch block, myocardial hypertrophy in both left and right ventricles, atria, their hemodynamic overload, and disruption of conduction. The interest in this technique is obvious, as shown by studies of electromotive force of the heart (EMF/H) in many countries of the world [3-7]. We have used a modern cardiodiagnostic complex MTM-SKM by Severodonetsk Scientific Production Association "Microtherm" (Ukraine), which allows the use of computer technology, from the first moments of patient monitoring with VCG-monitor, to make an automatic calculation of parameters, to increase questionable sections of the loop route 3000 times. In addition, the precardial electrode placement by polyhedron method, consisting of five projections, increases information about EMF/H.

Vectorcardiogram (VCG), as well as the ECG, is a form of graphical representation of the invisible biophysical phenomenon. However, the ECG in a single abduction gives scalar performance of the size of waves and of the duration of cardiac cycle phases, while VCG displays the magnitude and the direction of the resultant electric field of the heart during each of its activities [8]. With this in mind, VCG — study not only complements but significantly expands data collected from 12 conventional ECG abductions. For this purpose, the location of the electrodes is in such points over the area of the heart, that the axis of their abductions could give an opportunity to observe and study the whole period of EMF spread in the dynamics on the entire surface of the heart, maximally eliminating the so-called "dead zones", namely: in abduction I — from the front of the chest; in abduction II — roughly from the left shoulder and somewhat backwards with the primary visibility of the postero-lateral region of the left ventricle; in abduction III — from the right lowerphrenic areas; in abduction IV the visibility of the top is possible and in abduction V — of the base of the heart (in its usual location) [9]. Herewith loops P, QRS and T of VCG match the waves of ECG.

VCG diagnostics of MI is based on identification of the pathological symptoms of two kinds: MI symptoms that can be detected in ECG abductions that form this VCG-abduction, and symptoms of myocardial infarction that only vectorcardiography can detect (actually VCG-symptoms of MI) [10].

The evaluation of the simultaneous changes in loops QRS and T is the basis of focal myocardial changes recognition. Unclosed QRS and T loops, as well as the displacement of ST ECG intervals indicate the presence of unbalanced electrical forces in the phase of depolarization to repolarization transition. The electric forces of damage vector is directed with its positive pole to the center of necrobiosis and is referred to as vector ST. T loop in acute MI may have normal size, and there may be a decrease in the angle of deviation of its direction towards the initial part of QRS route and even further. The shape of the loop T resembles a horseshoe.

The polarity in the system of five precardial projections is important to evaluate VCG. Changes in the QRS loop spatial orientation in the system of coordinates is the proof of MI localization. In acute MI, a sharp spatial displacement of QRS loop, and especially its initial part, from the region of localization of the heart attack in the opposite direction. In the case of MI, necrobiosis affecting separate or large areas of myocardium do not give their portion of normal electrical forces, therefore unbalanced opposing electrical forces of intact areas "drag" QRS loop in the opposite direction from the focal.

In the VCG analysis in the case of acute coronary pathology the direction of QRS loop route in each projection is of great importance as an indicator of normal or pathological spread of excitation on the myocardium: clockwise or counter-clockwise.

The beginning of local intraventricular block in acute MI may be manifested in the form of additional QRS loop areas or in a simple change in the direction or orientation of its record in the system of coordinates.

In case of frequent timestamps over the VCG route it is possible to estimate the speed of loops and their parts recording. The concentration of timestamps means slowing down, and depression means acceleration of the excitation spread on the myocardium.

QRS loop shape can be changed in the case of intersections, convexities or the additional pole formation. The decreasing of QRS loop total area is typical, which is especially significant in the case of left ventricle aneurysm.

Clinical case

A clinical case can be an example of VCG method of high specificity and sensitivity in a patient with acute MI.

Patient D., 59, joined the infarction department of Luhansk Clinical Multihospital № 1 2.5 hours after the beginning of intense pressing pain in chest that radiated into the left arm and could not be stopped by nitroglycerin, as well as weakness and sweating. In anamnesis — Q-negative left ventricular posterior wall MI (2003), periodical high blood pressure for five years — 160/90 mmHg. He did not receive a regular scheduled outpatient therapy. Objectively: general condition is serious. Skin is pale and dry. Over patient's lungs a clear lung sound can be heard, hard breathing, no wheeze. The left border of the relative cardiac dullness at the left mid-clavicular line. Heart sounds are muffled; the activity is rhythmic; heart rate is 66 per minute. Blood pressure is 140/80 mmHg. The abdomen is soft and painless. Liver is at the costal arch margin. No peripheral edema is detected. Patient underwent ECG and VCG-study and biochemical blood test.

Discussion

ECG shows correct sinus rhythm, 66 per minute, the electrical axis of the heart is normal (the angle is a +57°), ECG voltage is saved. In abduction V_2 QS is registered, segment ST is on the isoline, T wave is weakly positive, in V_3 there is a pathologic Q wave with ST segment depression and biphasic T wave (-+). In Inferior abduction according to Nab there is a serrated QRS complex as the equivalent of pathologic wave Q, depressed ST that becomes a biphasic T wave (-+). These changes show the acute phase of the left ventricular anterio-septal area MI. In addition, there is an

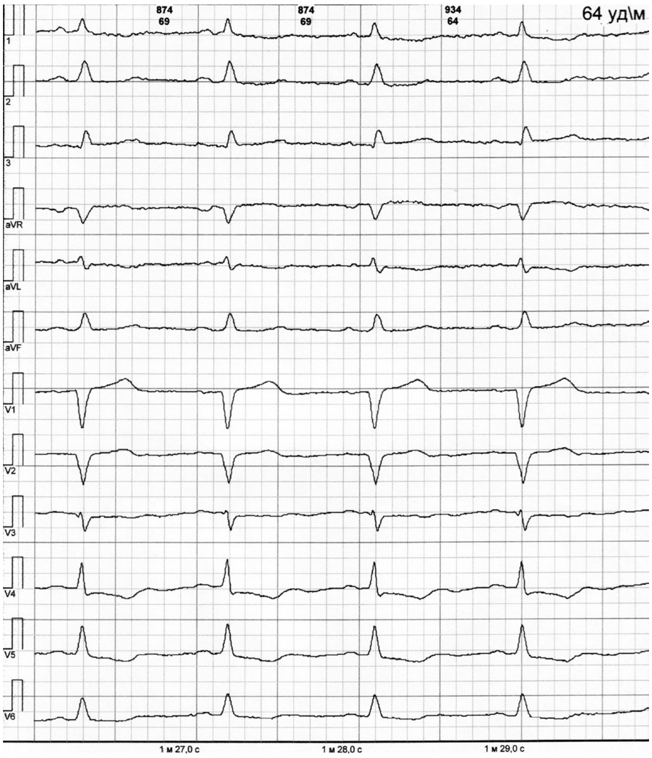

Figure 1. The electrocardiogram of the patient D.

obliquely downward depression of ST segment, that turns into negative T wave with relatively high R wave in abductions I, avL, V_{4-6}, and into V_{7-9}, Dorsalis and Anterior according to Nab, that is typical for hypertrophy of lateral and posterior-basal parts of the left ventricle. Along with this, the increase in P-wave duration to 0.12" may indicate a violation of intraatrial conduction (Figures 1, 2).

Myocardial necrosis is confirmed by an increase of blood protein cardiac troponin I to 4.285 ng/ml (normal 0-0.5 ng/ml) in the biochemical analysis.

VCG-study reported additional symptoms that were not detected in the ECG (Figure 3). The main vector in the system of coordinates is directed back to the left and upwards. At 1, 4 and 5 projections QRS loop rotation is not changed. In the 2nd projection the direction of the loop recording is clockwise; in the 3rd projection it is counter-clockwise, which is a deviation from norm. In BA_2 QRS loop starts in the 1st quadrant, and then goes into the 2nd quadrant. In BA_3 the signs of local intraventricular block are recorded — QRS loop is in the 4th quadrant with atypical direction of loop recording. In $BA_{2,3}$ QRS loops are in the bottom half of the system of coordinates, which means that the necrotic area includes a part of the left ventricular wall. In the 1st projection there is an indentation on the loop QRS contour. In all projections there is an intersection of QRS loop rout at the base, therefore the direction of the route of QRS and T loops is not the same.

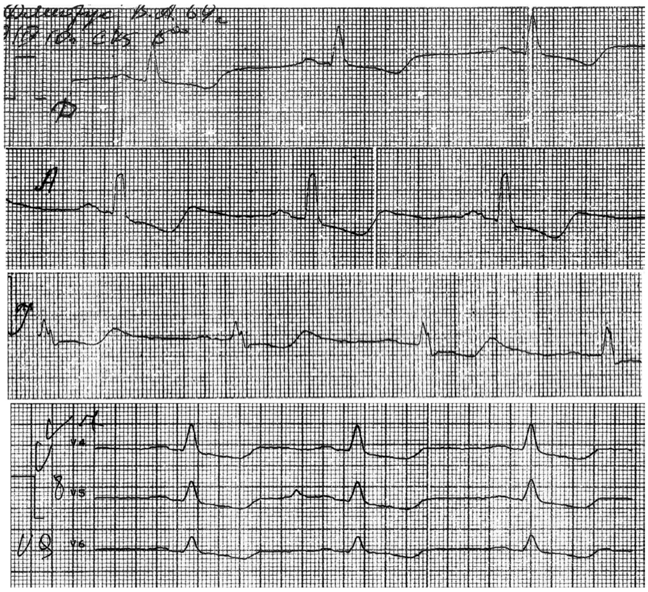

Figure 2. The accessory leads of the electrocardiogram.

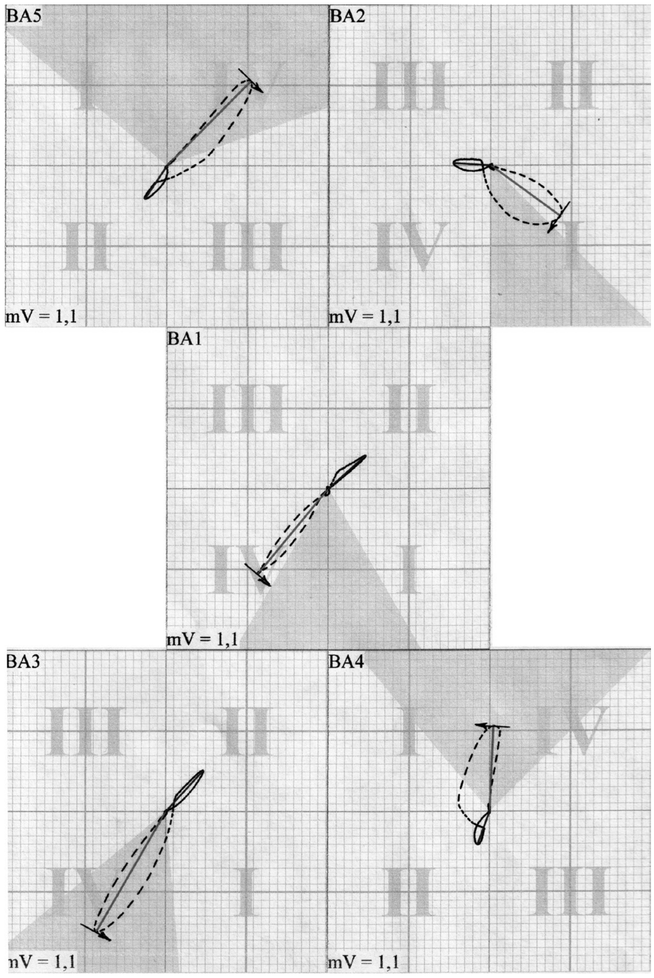

Figure 3. The vectorcardiogram of the patient D.

Table 1

Cardiogram indicators in patient D

Indicators	1st PROJECTION		2nd PROJECTION		3rd PROJECTION		4th PROJECTION		5th PROJECTION	
	Norm indicators	Indicators in patient	Norm indicators	Indicators in patient	Norm indicators	Indicators in patient	Norm indicators	Indicators in patient	Norm indicators	Indicators in patient
Maximum vector QRS, cm	1,06±0,096	1,54	0,65±0,10	1,20	0,99±0,18	1,93	1,20±0,08	1,19	1,25±0,10	1,65
Loops area QRS, mm^2	66,58±12,56	16,7	30,19±5,48	50,8	30,25±5,47	51,3	45,37±6,21	45,7	45,39±6,21	43,9
Vector angular convergence QRS-T, °	30±15	172	110±20	148	150±15	168	10±3	162	12±4	168
Maximum vector T, cm	0,64±0,09	0,66	0,37±0,09	0,49	0.48±0,13	0,72	0,63±0,09	0,47	0,55±0,08	0,52
Loops area T, mm^2	2,73 ±1,18	5,76	1,32 ±0,56	5,97	1,32±0,56	7,82	1,91±0,67	4,75	1,90±0,67	4,28
Maximum vector P, cm	0,14±0,03	0,098	0,10±0,02	0,075	0,09±0,02	0,117	0,12±0,02	0,088	0,15±0,03	0,136
Loops area P, mm^2	0,26 ±0,08	0,299	0,13 ±0,05	0,152	0,13 ±0,04	0,114	0,152±0,06	0,140	0,15 ±0,06	0,136
Vector angular convergence QRS-P, °	45±5	10	90±20	12	140±10	5	12±3	15	7±3	7

Table 2

The speed of excitation spread along loops QRS in patient D., mv/s

Projections	Loop routs	Norm indicators	Indicators in patient
1st PROJECTION	In the initial deviation vector	11,46±4,49	-
	In the final deviation vector	16,72±1,97	-
	In the initial part of the loop	40,84±3,80	40,9
	In the end part of the loop	41,49±2,79	26,34
2d PROJECTION	In the initial deviation vector	13,39±1,88	-
	In the final deviation vector	12,92±2,41	-
	In the initial part of the loop	28,92±3,24	28,71
	In the end part of the loop	24,10±2,76	26,11
3d PROJECTION	In the initial deviation vector	17,82±2,38	-
	In the final deviation vector	9,45	-
	In the initial part of the loop	41,96±5,71	43,58
	In the end part of the loop	28,39±4,13	25,83
4th PROJECTION	In the initial deviation vector	9,47±1,69	-
	In the final deviation vector	14,48±1,80	18,71
	In the initial part of the loop	40,23±3,02	29,84
	In the end part of the loop	44,59±2,30	33,65
5th PROJECTION	In the initial deviation vector	9,81±1,69	-
	In the final deviation vector	12,58±1,37	-
	In the initial part of the loop	44,70±4,03	37,29
	In the end part of the loop	44,43±2,92	30,86

The size of the maximum QRS loop vector is increased in the 1^{st}, 2^{nd}, 3^{rd} and 5^{th} projections. The area of the QRS loop is reduced 3 times in the 1^{st} projection and increased in $BA_{2,3}$ with the unchanged total of their area (Table 1). There is timestamps concentration in the ending part of BA_1 loop over the entire loop in the 4^{th} and 5^{th} projections (Table 2).

In the first three projections, T loop is located at the top, and in BA_4 it is located in the lower half of the system of coordinates. T loop area is increased 1.5-1.8 times in $BA_{1,4,5}$, and more than 3 times in the 2^{nd} and the 3^{rd} projections with an increase in the size of its maximal vector in $BA_{1\text{-}3}$. QRS-T angular divergence is increased in all projections. The speed of the excitation spread over T loops is slowed in the 1^{st}, 4^{th} and 5^{th} projections, and in the ending parts of loops in $BA_{2,3}$ (Tables 1 and 3). QRS and T loops are not closed in all projections: in BA_1 — 0.22 mV, in BA_2 — 0.11 mV, in BA_3 — 0.14 mV, in BA_4 — 0.25 mV, and in BA_5 — 0.21 mV. The electric forces of damage vector ST is directed upwards and to the right (Figure 4).

Thus, the backwards to the left and upward shift of the main vector in the system of coordinates, the change in QRS loops direction and location in the 2^{nd} and 3^{rd} projections, QRS loop contour indentations and reducing of its area in the 1^{st} projection, intersection at the base of QRS loop in all projections; increase in QRS-T loops angular divergence; vector direction to ST necrosis forward, up and to the right; the violation of intraventricular conduction on the left ventricle front wall; the apex and the basal parts of the left and apparently, the right ventricles are the evidence of the left ventricular antero-septal myocardial-apical area acute MI.

In the loops P, analysis of the increase in their area in the 1^{st} projection at the unchanged maximum size of the vector is noteworthy. In addition, there is timestamps concentration in $BA_{1,2}$, and in the end part of P loops in the 4^{th} and 5^{th} projections. These changes indicate the signs of hemodynamic overload of the atria and intraatrial conduction disturbances in the front and back walls of the atria, the postero-lateral region of the left atrium (Table 1, 4; Figure 5).

Almost 1.5 times increase in the area of QRS loop in the 2^{nd} and 3^{rd} projections with the broadening of loop peak in BA_2 together with the focal changes of the myocardium indicate the myocardial hypertrophy of the left ventricular posterior-lateral area.

On the second night in the hospital the patient had a paroxysm of atrial arrhythmias and the subsequent shock

Table 3

The speed of excitation spread along loops T in patient D., mv/s

Projections	Loop route	Norm indicators	Indicators in patient
1 PROJECTION	In the initial part of the loop	5,38±0,85	2,54
	In the end part of the loop	8,78±1,31	5,47
2 PROJECTION	In the initial part of the loop	3,48±0,73	2,26
	In the end part of the loop	4,99±1,14	4,06
3 PROJECTION	In the initial part of the loop	4,51±1,08	3,08
	In the end part of the loop	6,49±1,62	5,29
4 PROJECTION	In the initial part of the loop	5,29±0,78	1,54
	In the end part of the loop	8,65±1,38	3,67
5 PROJECTION	In the initial part of the loop	4,60±0,59	1,66
	In the end part of the loop	7,84±1,12	5,15

Table 4

The speed of excitation spread along loops P in patient D., mv/s

Projections	Loops route	Norm indicators	Indicators in patient
1st PROJECTION	In the initial part of the loop	3,34±0,43	2,76
	In the end part of the loop	3,52±0,52	2,52
2nd PROJECTION	In the initial part of the loop	2,61±0,33	2,13
	In the end part of the loop	2,59±0,43	1,68
3d PROJECTION	In the initial part of the loop	2,65±0,34	2,68
	In the end part of the loop	2,20±0,29	2,02
4th PROJECTION	In the initial part of the loop	2,74±0,35	2,28
	In the end part of the loop	3,26±0,51	2,35
5th PROJECTION	In the initial part of the loop	3,14±0,43	3,26
	In the end part of the loop	4,13±0,63	3,38

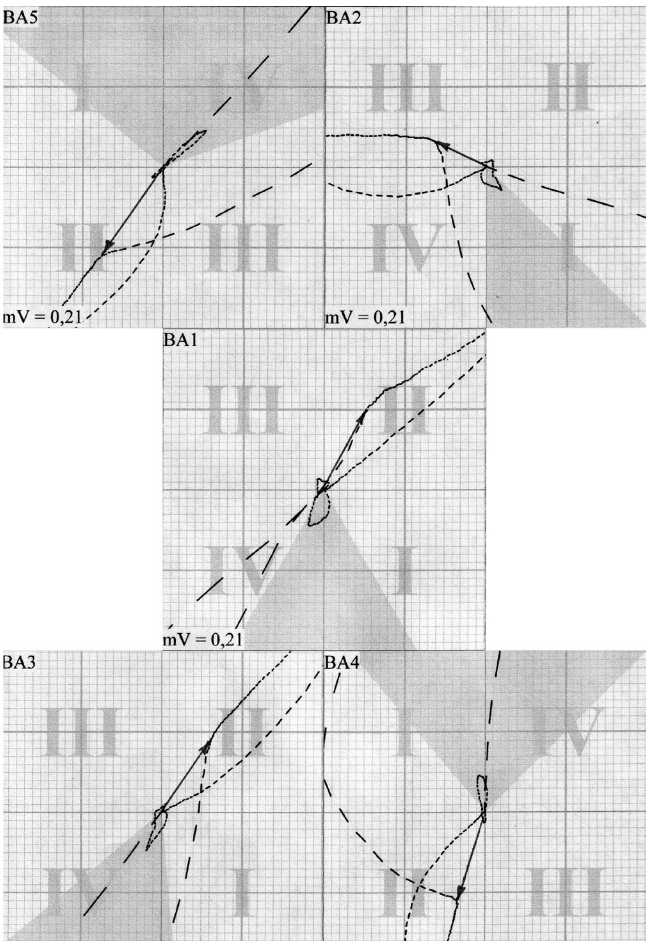

Figure 4. Damage vector ST of the vectorcardiogram is registered in all projections (for zooming in 600 times).

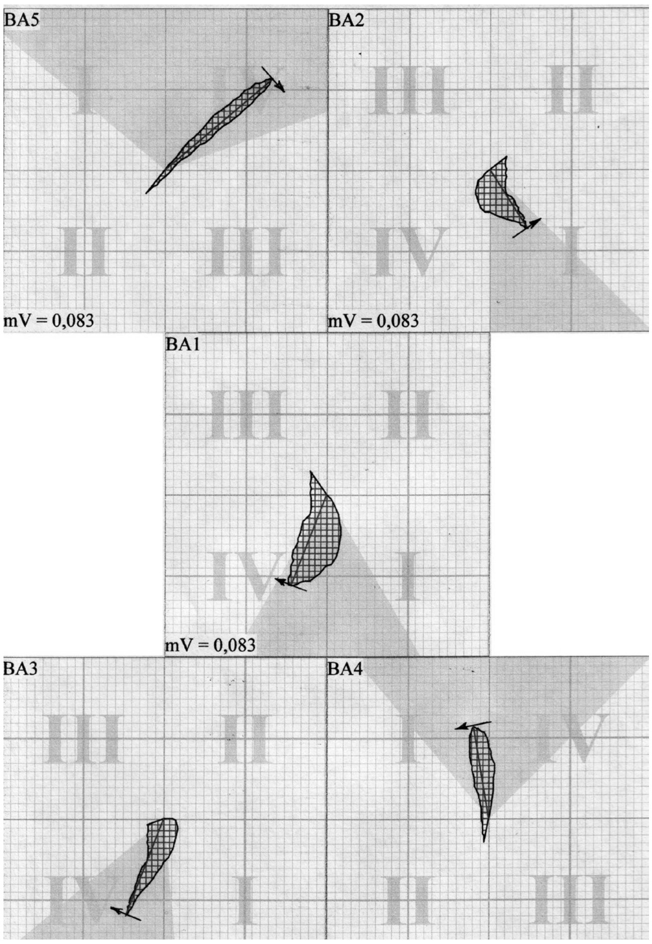

Figure 5. P loops of the vectorcardiogram for zooming in 1500 times.

and pulmonary edema. Drug therapy and electrical cardioversion were not effective. Clinical, and then biological death were pronounced on the background of asystole. The cause of death at postmortem examination is the pulmonary edema due to the left ventricular anterior-apical region acute myocardial reinfarction.

Conclusion

Additional information obtained after the complex electrophysiological examination of patients (that includes VCG and ECG), allows a real-time evaluation of the myocardium functional state with the detailed information on the degree, depth and spread of the pathological process.

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PNEUMOTHORAX AND SUBCUTANEOUS EMPHYSEMA AFTER PACEMAKER IMPLANTATION

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Key words: pacemaker implantation, pneumothorax, subcutaneous emphysema.

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ПНЕВМОТОРАКС И ПОДКОЖНАЯ ЭМФИЗЕМА ПОСЛЕ ИМПЛАНТАЦИИ ЭЛЕКТРОКАРДИОСТИМУЛЯТОРА

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Ключевые слова: имплантация электрокардиостимулятора, пневмоторакс, подкожная эмфизема.

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82-year-old patient with arterial hypertension and chronic obstructive lung disease was admitted to cardiac ward due to second — degree atrioventricular block in order to pacemaker implantation. A DDDR pacemaker was implanted via left subclavian vein puncture with use of active fixation leads for both atrial and ventricular pacing. Pacemaker control confirmed dual chamber stimulation mode with appropriate electrical parameters of ventricular and atrial channel. At the next day after pacemaker implantation the patient became rapidly dyspneic. In chest X-ray posteroanterior examination left-sided pneumothorax with dislocation of the mediastinum to the right hemithorax was elucidated (Figure 1A). Decision of invasive pneumothorax removal was taken. Surgeon inserted

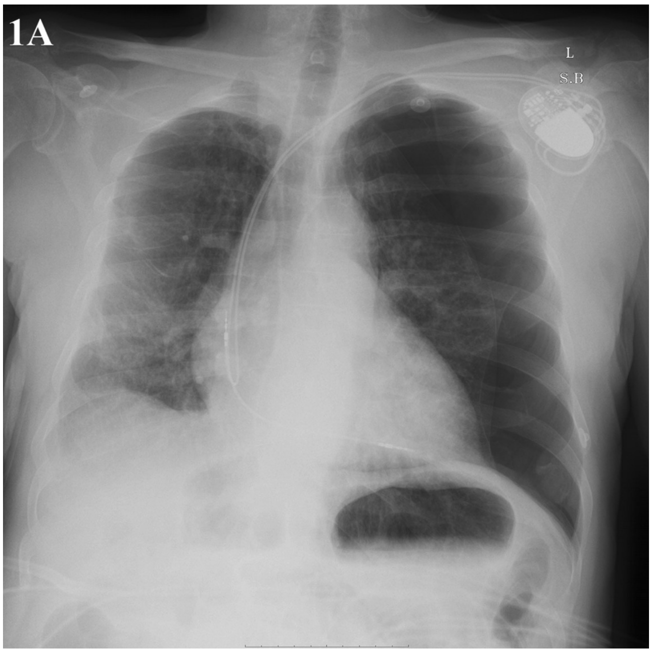

Figure 1A. Chest X-ray acquired 24 hour after placement of dual chamber pacemaker showing left-sided pneumothorax (arrow) with a shift of the mediastinum to the right side of the thorax.

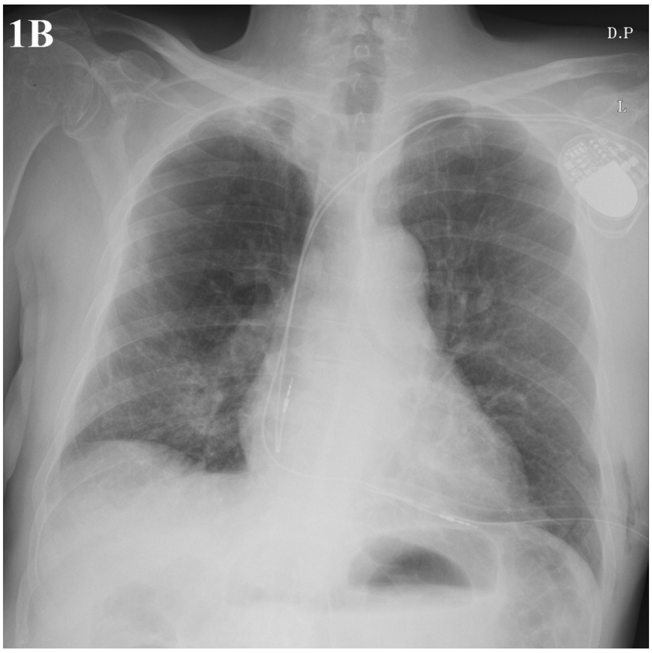

Figure 1B. Chest X-ray — state directly after pneumothorax evacuation; in pleural space visible chest tube.

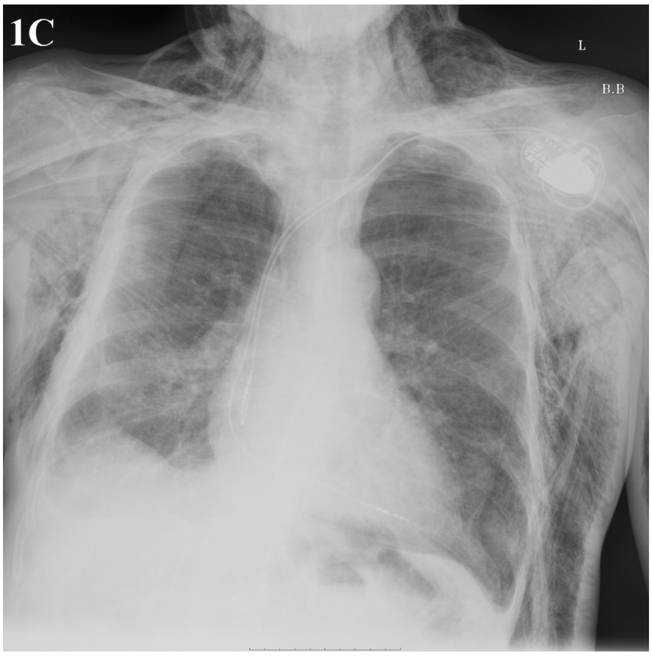

Figure 1C. Chest x-ray showing diffuse subcutaneous emphysema (arrows).

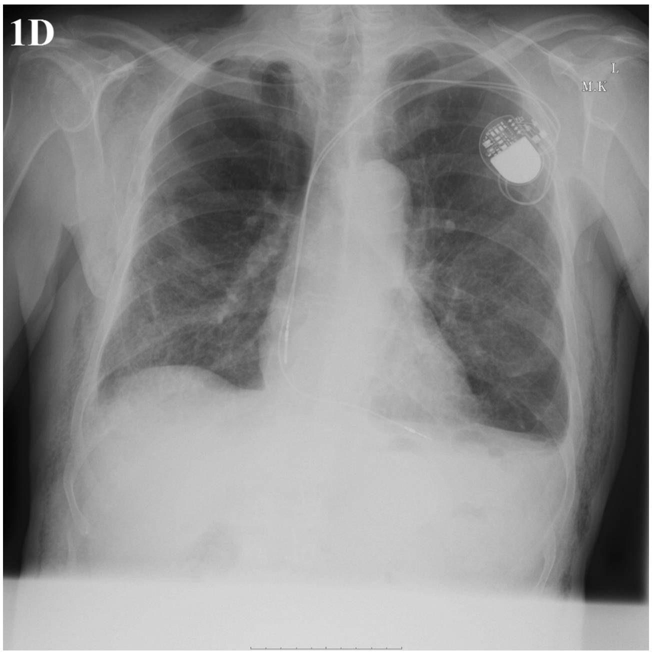

Figure 1D. Chest x-ray after 14 days — visible significant reduction of subcutaneous emphysema.

chest tube into the pleural space. Control chest X-ray showed significant reduction of pneumothorax (Figure 1B). Pacemaker interrogation revealed no change in lead data. After 7 days of therapy the surgeon removed chest tube. The removal was followed by large subcutaneous emphysema occurrence (Figure 1C). During the next 14 days observed was gradual reduction of subcutaneous emphysema confirmed by serial chest X-rays (Figure 1D).

Pacemaker implantation is connected with potential risk of complications. The complications could be divided into acute — directly after implantation, early — up to 3 months and late — beyond 3 months. As acute complications considered are: pneumothorax, bleeding into pleural space, hematoma, heart wall or central vein perforation, diaphragm or skeletal muscle stimulation, electrode dislocation and inappropriate functioning of pacemaker or electrode. The long-term complications are: pacemaker pocket infection, thrombosis or occlusion of vein with inserted electrodes, twiddler's syndrome. The presented patient had pneumothorax complicated by subcutaneous emphysema. The cause of pneumothorax occurrence was insertion of pacemaker electrodes via subclavian vein. More safe method of electrode placement seems to be cephalic vein preparation. Method of instrumental healing of pneumothorax is punction of pleural space with chest tube insertion — procedure that is also connected with a risk of complications.

Pneumothorax is usually a complication of percutaneous insertion to the subclavian vein. The clinical course of pneumothorax could be variable: from nearly asymptomatic to clinical course presenting with acute signs and symptoms such as dyspnea, chest pain, cyanosis and shock. In every case of patient with pneumothorax before chest tube insertion potential benefits and risk of complications accompanying the procedure should be considered.

GIANT LEFT ATRIUM WITH MECHANICAL MITRAL PROSTHESIS, SMALL PARAVALVULAR LEAK AND DISLOCATED PACEMAKER ELECTRODE

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Giant left atrium (GLA) is defined as those measuring larger than 8 cm and are typically found in patients who have rheumatic mitral valve disease with severe regurgitation. GLA is a rare condition, with a reported incidence of 0,3%.The patient usually presents with complaints of shortness of breath and/or dysphagia. The correct diagnosis of GLA is at times not possible through the routine chest roentgenogram and may require echocardiography, computerized tomography or cardiac MRI to reach a diagnosis. GLA is associated with complications such as heart failure, valvular heart disease, dislocations of electrode. Patients with GLA are candidates for surgical/catheter interventional treatment at any age.

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Key words: giant left atrium, mechanical mitral prosthesis, paravalvular leak, dislocated pacemaker electrode, echocardiography.

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ГИГАНТСКОЕ ЛЕВОЕ ПРЕДСЕРДИЕ С МЕХАНИЧЕСКИМ МИТРАЛЬНЫМ ПРОТЕЗОМ, НЕБОЛЬШОЙ ПАРАВАЛЬВУЛЯРНОЙ НЕСОСТОЯТЕЛЬНОСТЬЮ И СДВИГОМ ЭЛЕКТРОДА КАРДИОСТИМУЛЯТОРА

Piotr J Stryjewski[1], Agnieszka Kuczaj[2], Jadwiga Nessler[3], Ewa Nowalany-Kozielska[2]

Гигантское левое предсердие (ГЛП) определяется как сумма измерений превышающая 8 см и обычно встречаются у больных, имеющих ревматическое поражение митрального клапана с тяжелой регургитацией. ГЛП — это редкое состояние, с документированной встречаемостью 0,3%. Больной, как правило, жалуется на одышку и/или дисфагию. Правильный диагноз ГЛП порой не представляется возможным по рутинной рентгенограмме грудной клетки, и может потребоваться эхокардиография, компьютерная томография или МРТ сердца, чтобы достичь точного диагностического результата. ГЛП связано с осложнениями, такими как сердечная недостаточность, пороки сердца, сдвиги электрода. Пациенты с ГЛП являются кандидатами для хирургического/катетер оперативного вмешательства в любом возрасте.

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Ключевые слова: гигантское левое предсердие, митральный механический протез, паравальвулярная несостоятельность, сдвиг электрода кардиостимулятора, эхокардиография.

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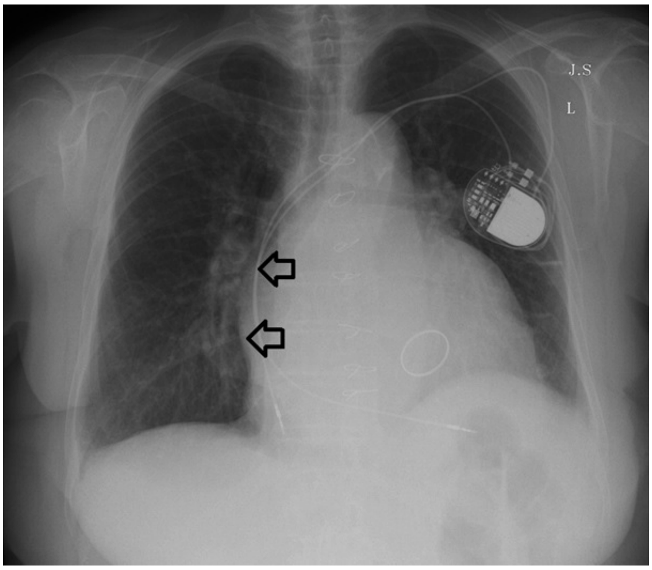

Figure 1. Chest radiograph in the antero-posterior view revealing marked prominence of the right cardiac border (arrowheads) consistent with left atrial enlargement.

Giant left atrium is a rare disease, with a reported incidence of 0,3%, defined as left atrium dimension larger than 8 cm. The disease is typically found in patients with rheumatic mitral valve disease [1-3]. Late electrode displacement, occurring after the first six weeks post implantation is rare and remarkable [4].

A 83-year-old female patient was admitted to the Cardiology Ward because of decompensated heart failure. The patient underwent a mitral valve replacement for rheumatic mitral valve disease with St. Jude mechanical prosthesis ten years ago and had performed pacemaker implantation due to atrioventricular conduction disorders. Clinically, at the time of admission, she was conscious, alert, oriented to person, place and time. Her blood pressure was 135/85 mmHg with regular pulse of 85 beats per minute. Heart examination revealed the sharp click of the prosthesis with a grade 2 to 3 pansystolic murmur at the apex. Lung examination showed mild bilateral basal crepitation. ECG showed atrial fibrillation with appropriate right-ventricular pacing.

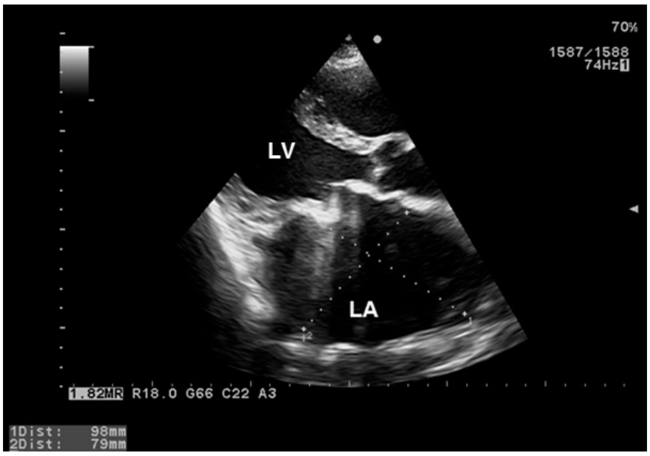

Figure 2. Transthoracic echocardiogram (parasternal short-axis view) of the left atrium (LA).

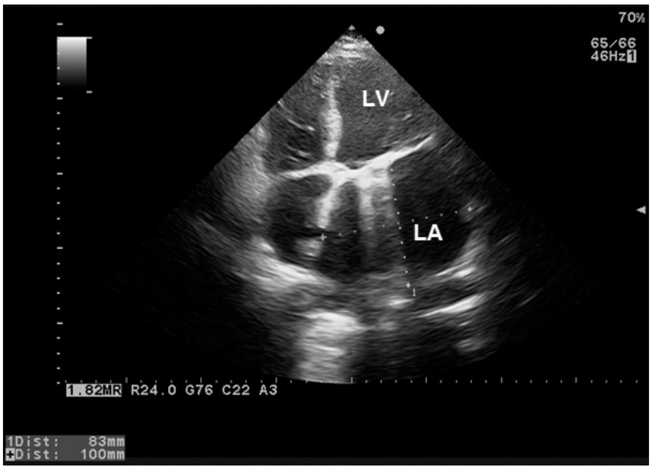

Figure 3. Transthoracic echocardiogram (apical 4-chamber view), showing the disproportionate size of the left atrium (LA) compared with the left ventricle (LV) and the other cardiac chambers.

Chest radiograph in the anterior-posterior view revealed, besides signs of congestion, marked prominence of the right cardiac border (arrowheads) consistent with enlarged left atrium with well-seated mitral valve prosthesis (Figure 1). Furthermore, noticeable was dislocated right atrial electrode with the tip located in inferior vena cava.

Transthoracic echocardiography showed a markedly dilated left atrium diameter — 79 mm (PLAX) (Figure 2), 83x100 mm (A4C) (Figure 3), estimated volume — 71,5 cm^2. The rest ejection fraction was 40%.

A transesophageal echocardiography examination was performed to assess the mitral valve prosthesis and the electrodes. The bileaflet prosthesis was well seated. There was small mitral paravalvular leak in left atrium (Figure 4). Right atrial electrode had no visible vegetation.

A diagnosis of decompensated heart failure with giant left atrium and dislocated right atrial electrode was made. Oral treatment with furosemide, spironolactone and angiotensin receptor blocker was prescribed and warfarin was continued. The patient was scheduled for pacemaker replacement with simultaneous right atrial electrode removal.

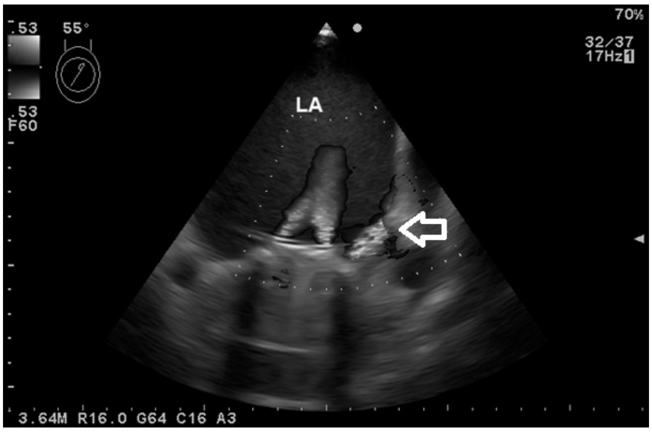

Figure 4. Transesophageal two chamber view demonstrating small mitral paravalvular leak (arrowhead).

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