Current Topics in Sports Medicine

Proceedings of the
World Congress of Sports Medicine,
Vienna 1982

Editors
N. Bachl, L. Prokop, R. Suckert

Urban&Schwarzenberg
Wien–München–Baltimore 1984

Contents

A. Sport and Age

A.8. Incidence Of Ergometric Stress Testing In Elderly People For Clinical Purpose.[1)]

W. Reiterer, M.D.

Poliklinik, I. Med. Abt., Vienna, Austria.
Univ. Doz. Dr. W. Reiterer
Poliklinik, A-1090 Wien

Summary

At the cardio-pulmonary function lab of a municipal hospital, 3438 non-invasive dynamic stress tests have been performed between 1974 and 1981, including 1097 computer-assisted ergospirometric stress tests (2-min increment bicycle ergometry). 73 patients (2.1%) older than 70 years (70 male, 3 female) tolerated work loads ranging from 75 to 125 watts. They had to discontinue the test mainly due to physical exhaustion (muscular fatigue). In 21 patients (28.7%) abnormal reactions were missed, but in 24 patients (33%) we observed a marked ST-depression (more than 0.2 mV in precordial chest leads), which has been the main reason to stop the test. Other observations include severe angina pectoris (10/73), severe arrhythmias (8/73), and excessive increase (4/73) and decrease (4/73) of the systolic blood pressure. The overall age distribution curve in 1981 points out the predominance of patients older than 50 years (61.1%), including 6.5% of the seventh decade. The age per se is not regarded in our opinion as a criterion to restrain elderly people from symptom-limited maximal stress testing, as otherwise important information for clinical purpose are lost: the onset of abnormal reactions of the cardio-pulmonary system in relation to daily life activities and the rational basis for efficient medical treatment (e.g. afterload, heart rate, ischemic reactions, arrhythmias).

[1)] The investigation has been supported by grants Nr. 831, 1081 and 1676, Jubiläumsfonds Österr. Nationalbank.

A.8.1 Introduction

Ergometric stress testing is a well-accepted diagnostic tool to assess the functional capacity of the cardio-pulmonary system. For clinical purposes, valuable information will be obtained about the blood pressure and heart rate regulation, the ECG with respect to ischemic reactions and arrhythmias, and subjective complaints and their objectives. Besides the clinical investigation at rest, the findings at work contribute to a comprehensive analysis of the physical performance of the subject (2,4,5,10,17,18).

With advancing age, the ability to adapt and to recover from physiological stress is impaired. The performance may be limited by either an inadequate response or by inadequate integration of the responses of several organ systems (7,8,9,16). In addition to the effects of aging per se, the cardio-pulmonary functional capacity is hampered by evident or latent disease. A retrospective analysis was done to assess the frequency of participation of elderly people of the seventh decade in ergometric stress testing and their performance at work.

A.8.2 Method and material

The test protocols of ergometric and computer-assisted ergospirometric stress tets between 1974 and 1981 have been evaluated with respect to the age distribution and to the reasons for terminating the stress test in people of the seventh decade.

A non-steady-state bicycle ergometer test was used (2-min increment test, rectangular-triangular bicycle ergometry), which has been accepted as the standardized procedure for clinical purpose of exercise testing in Austria (1978). The test model and normal ranges of physiologic parameters have been described in detail elsewhere (11,12,13). In elderly people, the work loads were incremented by 25 watts until the subject was physically exhausted or abnormal reactions led to an abrupt termination of the test. Ergospirometric bicycle ergometry was performed following the same test protocol. Data of ventilation and respiration were assessed by means of an open air circuit system (Ergopneumotest mit EDV, Jäger BRD) on-line. Certain parameters of physical performance were documented by print-out and graphic display: anaerobic and aerobic

power, the adaptation to work load increments, and the anaerobic threshold. The parameter of metabolic acidosis (base excess) was calculated from blood gas analysis.

A.8.3 Results and interpretation

3438 stress tests on the bicycle ergometer have been performed in the sitting position between 1974 and 1981, including 1097 stress tests with the computer-assisted analysis of ergospirometric data. The order statistics of the analysis are shown in Fig.1 and Fig.2. During 1975 and 1976 an equal number of ergometric and ergospirometric tests were performed as research work was done to establish normal ranges of parameters such as oxygen uptake, minute ventilation volume, expiratory flow, heart rate, and blood pressure regulation. An algorithm was tested to calculate on-line an index of anaerobic power involved during non-steady-state exercise and to rate actual data in comparison to the reference data. For the routine analysis of the anaerobic threshold we introduced the graphical display of paired data of oxygen uptake and minute ventilation volume to identify the onset of hyperventilation in contrast to the linear increase of both parameters at work. In the later years, the relationship between ergometric and ergospirometric stress testing decreased to 4:1-5:1.

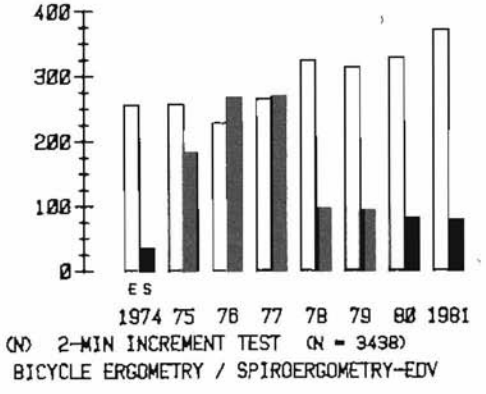

Fig. 1: Order statistic of ergometric (open bar) and ergospirometric (black bar) stress testing at a municipal hospital.

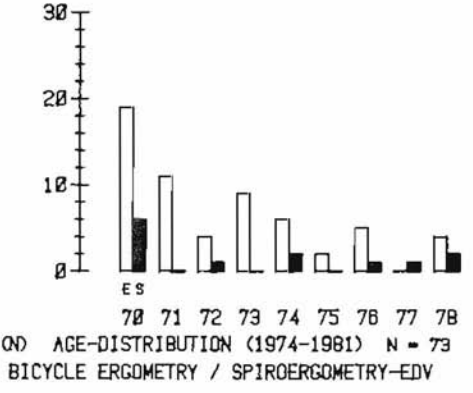

Fig. 2: Age distribution of patients of the seventh decade participating in ergometric (open bar) and ergospirometric stress testing (black bar).

73 subjects (70 male, 3 female) of the seventh decade have been identified, 2.1% of the total number of stress tests performed at the cardio-pulmonary function lab of a community hospital. In 1981 a shift of the age distribution to the right became evident, as 61.1% of the patients (370 ergometric stress tests) were older than 50 years, 6.5% belonging to the seventh decade (Fig.3). The age distribution of the patients is outlined in Fig.3 in relation to ergometric (N = 60) and ergospirometric (N = 13) stress tests.

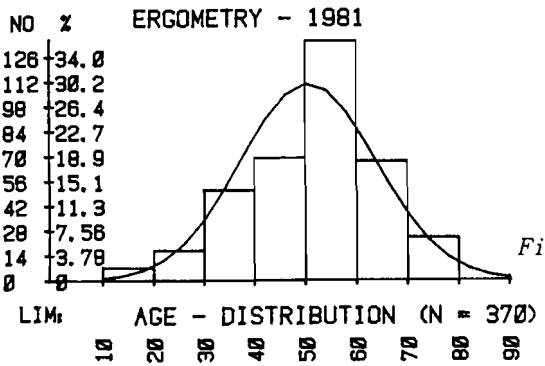

Fig. 3: Age distribution curve of patients (N = 370) undergoing bicycle ergometry in 1981 - prevalence of elderly people.

The analysis of abnormal reactions at work and the main reasons to terminate the test reveals the following. First of all, in 21 patients (28.7%) abnormal reactions are missing and they discontinued the ergometer work due to muscular fatigue. In 52 patients (71.2%) the exercise test was stopped for safety reasons: marked ST-depression (more than 0.2 mV) in 24 patients (32.9%), severe angina pectoris in 10 cases (13.7%), malignant arrhythmias (Lown III-IV) in 8 patients (11.0%), severe dyspnea (no exercise-induced asthma) in 2 patients (2.7%), excessive arterial hypertension (systolic blood pressure exceeding 240 mm Hg) in 4 cases (5.5%) and unexpected decrease of the systolic blood pressure in 4 cases (5.5%). The incidence of abnormal reactions at work is influenced by the population sample and by the prevalence of disease, which is likely to increase in elderly people. It is not intended to present a representative population sample by these findings, in fact I want to make the point that stress testing is a very individualistic procedure the findings of which cannot be generalized. It is not the main goal to set up a certain diagnosis (for example to exclude the presence of coronary heart disease), but to describe the functional capacity of the cardio-pulmonary system with respect to the onset and severity of

abnormal reactions (1,6,14). 13 patients of the seventh decade participated in ergospirometric stress testing. The findings of selected parameters related to age and work load (2nd minute of the load) are presented in Fig.4, Fig.5, Fig.6, Fig.7. The correlationships between $\dot{V}O_2$ max and age, maximal work load and age, base excess and maximal work load refer to a random distribution. Due to the low number of observations and the different physical performance capacity of the elderly people the data can only be analyzed from an individualistic standpoint. The oxygen uptake at higher work rates (100, 125 watts) remains below the reference data for sedentary men aged 20-45 ($\dot{V}O_2$-100 watt: 1.52±0.13 l/min; VO_2-125 watt: 1.79±0.13 l/min). It was interesting to note that the patients more or less suddenly stopped the bicycle ergometer work due to muscular fatigue. With the exception of 2 cases, it

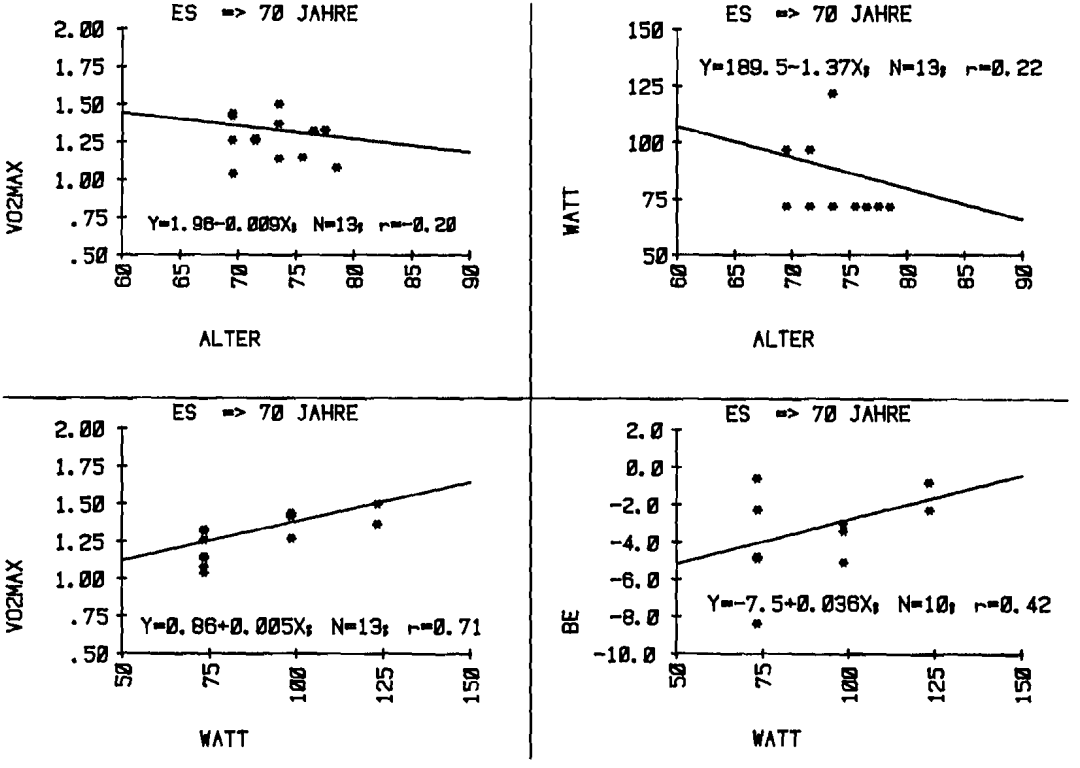

Fig. 4-7: Ergospirometric stress testing in patients of the seventh decade (N = 13). Relationship between maximal oxygen uptake and age, maximal work output and age, maximal oxygen uptake and work output, and between base excess (BE) and work output.
$\dot{V}O_2$max = oxygen uptake (l/min), work load = watts, BE = base excess (mmol/l). 2-min increment test - rectangular-triangular bicycle ergometry.

was impossible to calculate the level of endurance performance from the slope of the relationship between oxygen uptake and minute ventilation volume, as no distinct sign of hyperventilation occurred.

For clinical and practical purpose it is more advisable to study the usefulness of test models that will probably result in a comprehensive analysis of the motor function of elderly people, including muscle strength, coordination, and flexibility, to delineate the functional capacity in some essential activities of daily living (3,15). To preserve an unlimited high physical performance for the seventh decade, it seems to be useful from a standpoint of preventive medicine to perform stress tests at an earlier time repeatedly to quantify abnormal reactions in time.

Notwendigkeit ergometrischer Belastungstests für klinische Fragestellungen bei älteren Menschen

Von 1974 bis 1981 wurden 3.438 nichtinvasive dynamische Belastungstests inklusive 1.097 computer-ergometrischer Belastungstests (2-Minuten-Stufen, rektangulartriangulare Fahrradergometrie) durchgeführt.

73 Patienten (2.1%) über 70 Jahre (70 Männer, 3 Frauen) tolerierten Belastungen von 75 bis 125 Watt. Sie mußten den Test zumeist wegen körperlicher Erschöpfung abbrechen. Bei 33% der Fälle wurde eine deutliche ST-Depression gesehen, die teilweise unsymptomatisch war (subjektive anginöse Beschwerden bei 14%; 10/73).

Abnorme Reaktionen wie schwere Dyspnoe (2/73), ernste Arrythmien (8/73) und ein exzessiver Blutdruckanstieg (4/73) sowie ischämische EKG-Veränderungen (24/73) erzwangen die Unterbrechung des Tests.

Die allgemeine Altersdistribution im Jahr 1981 ergab die Prädominanz der über 50 Jahre alten Paitenten:
20 - 29 (4.9%); 30 - 39 (13.8%); 40 - 49 (18.4%); 50 - 59 (36.5%); 60 - 69 (18.1%); 70 - 78 (6.5%).

Das Alter per se ist nicht als Kriterium zur Ausschließung der Patienten von einem Belastungtest anzusehen, andernfalls würden für die klinische Praxis wichtige Informationen verloren gehen: Anfälle von abnormen Reaktionen des kardiopulmonalen Systems bei obligaten täglichen Lebensaktivitäten, die eine rationelle Basis für effektive ärztliche Behandlung darstellen, desgleichen auch Toleranz von physischem Streß bei älteren Menschen.

References

1 Amsterdam,E.A., Wilmore,J.H., Dressenhofer,R.H., and Mason,D.T.: Exercise testing in symptomatic and asymptomatic populations: Diagnosis and prognostic implications. In Mason D.T. (ed): Advances in Heart Disease. Volume 2. New York, Grune & Stratton, 1978, pp 331-344.

2. Andersen,K.L., Shephard,R.J., Denolin,H., Varmauskas,E. and Masironi,R. (eds): Fundamentals of exercise testing. Geneva, World Health Organization, 1971.

3. Aniansson,A., Rundgren,A. and Sperling,L.: Evaluation of functional capacities in activities of daily living in 70-years-old men and women. Scand. J. Rehab. Med. 12:145-154, 1980.

4. Åstrand,P.O.: Aerobic and anaerobic work capacity. In Jokl,E., Anand,R.L. and Stoboy,H. (eds): Advances in Exercise Physiology. Medicine and Sport, Vol. 9. Basel, S. Karger, 1976, pp 55-60.

5. Bartel,A.G.: Exercise stress testing - current status. Cardiology 64:170189, 1979.

6. Myrvin,H.E.: Can stress testing identify the severity of coronary disease? In Corday,E. and Swan,H.J.C. (eds): Clinical strategies in ischemic heart disease. Baltimore, Williams & Wilkins, 1979, pp 208-219.

7. Franz,I.W.: Ergometrische Untersuchungen zur Beurteilung des hohen Blutdruckes im Alter. Herz/Kreisl. 13:197-205, 1981.

8. Hollmann,W.: Alter und Leistungsfähigkeit. In K.Jahnke, H.Mehnert, u. Reis,H.E. (eds): Muskelstoffwechsel, körperliche Leistungsfähigkeit und Diabetes mellitus. Stuttgart, F.K.Schattauer, 1977, pp 163-168.

9. Kuramoto,K., Matsushita,S., Kuwajima,I., Iwasaki,T. and Murakami,M.: Comparison of hemodynamic effects of exercise and isoproterenol infusion in normal young and old men. Jap. Circ. J. 43: 72-76, 1979.

10. Niederberger,M., Kubicek,F., und Reiterer,W.: Leitlinien für die Ergometrie. Acta Med. Austriaca 2:33-48, 1975.

11. Reiterer,W.: Methodik eines rektangulär-triangulären Belastungstestes. Herz/Kreisl. 7:457-462, 1975.

12. Reiterer,W.: Evaluation of physical performance by rectangular-triangular bicycle ergometry and computer-assisted ergospirometry. Basic Res. Cardiol. 71:482-503, 1976.

13. Reiterer,W., Czitober,H.: Neue Aspekte zur Beurteilung der körperlichen Leistungsfähigkeit. Verhl. Deutsch. Gesell. Inn. Med.: 83:1764-1766, 1977.

14. Reiterer,W., Feichtinger,M.L. and Czitober,H.: Physical performance in the early phase after acute myocardial infarction evaluated by invasive and noninvasive stress testing. In Mason,D.T., Serneri, N.G.G. and Oliver,M.F. (eds.): Florence international meeting on myocardial infarction. Proceedings: Volume II. Amsterdam, Excerpta Medica, 1979, pp 764-766.

15. Ryan,J.A.: The concept of physical fitness. In Ryan,A.J. and Allman,F.L. (eds.): Sports medicine. New York, Academic Press, 1974, pp 31-57.

16. Skinner,J.S.: Age and Performance. In Keul,J. (ed): Limiting factors of physical performance. Stuttgart, Georg Thieme, 1973, pp 271-282.

17. Vatner,F.S. and Pagani,M.: Cardiovascular adjustments to exercise: hemodynamics and mechanisms. Progr. Cardiovasc. Dis. 19:91-108, 1976.

18. Zohmann,R.L.: Exercise stress test interpretation for cardiac diagnosis and functional evaluation. Arch. Phys. Med. Rehabil. 58: 235-240, 1977.