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Clinical and hygienic aspects of absolute (dry) fasting

AUTHOR'S ABSTRACT
of a thesis for the degree of Candidate of Medical Sciences
(abridged translation from Russian)

The study was conducted at the Military Medical Academy in St. Petersburg in 1994.

Research objectives

1. To study the dynamics of physical and mental performance and basal metabolic rate during a absolute (dry) 3-day fast

2. To evaluate the functional state of the cardiovascular, digestive and urinary systems under these conditions.

3. To study the state of protein, carbohydrate, lipid, water and mineral metabolism during a absolute fast.

4. To study the changes in the neurohumoral regulation of the body in the complete absence of food and water.

5. Identify the main factors leading to the disruption of homeostasis resulting from a prolonged absence of food and water.

6. To develop clinical and laboratory criteria for assessing the severity of the condition of patients who experienced the absence of food and water.

7. To propose and test a new method of therapeutic fasting – a 1-3 day absolute (dry) fast.

Scientific novelty

- This is the first thorough and comprehensive study of the state of the organs and systems of the body, metabolism, mental and physical performance, basal metabolic rate and total energy expenditure under conditions of a complete 3-day absence of food and water.

- New data were obtained by assessing the body's macrostructure, and a calculation of the amount of metabolized proteins, carbohydrates, fats and water losses during alimentary and water deprivation.
- The main links of neurohumoral regulation and human mechanisms of endocrine/metabolic adaptation to a complete absence of food and water are revealed.
- The most informative clinical and laboratory indicators were determined. These indicators were used to develop criteria for assessing the severity of the condition of the patients who experienced prolonged alimentary and water deprivation.
- For the first time, the algorithm of water and food rehabilitation of patients who stayed in a small enclosed space without food and water was scientifically substantiated.
- A new RDT[1] technique, which entailed a 1 to 3-day dry fast was developed and applied in the clinic.

Scientific provisions to be defended

1. A three-day absolute (dry) fast does not lead to pronounced metabolic disorders, morphological and functional state of organs and systems, and significant dehydration of the body in healthy or ill people between 20 and 55 years of age under regular temperature conditions (15 - 30 ° C).
2. A short (24-72 hours) absolute (dry) fast during the first stage of a fasting therapy course is indicated for stage 1-2 hypertensive disease combined with alimentary and constitutive obesity, bronchial asthma and chronic asthmatic bronchitis, chronic gastritis and gastroduodenitis, metabolic arthropathies and skin allergies.

SCOPE OF WORK

1. General description of research methods

1.1. Research on laboratory animals

The study presents the results of the experimental comparative study of the influence of the wet (with water) and absolute (without water) fasting on the bodies of laboratory animals (60 Whistar white male rats). The preparatory stage entailed experimental comparative studies of the influence of wet and absolute fasting on the bodies of laboratory animals – Wistar white male rats, weighing 170 g to 235 g.

[1] The 'RDT' abbreviation used in this paper is commonly used by doctors of the Russian fasting school. The term was introduced by Yuri Nikolaev in the 1960s, and is synonymous with the concept of therapeutic fasting.

Animals were divided into 3 homogeneous groups:
1) absolute fast: deprived of food and water,
2) wet fast: deprived of food; unlimited water intake;
3) control group: regular diet.

Room temperature of 18-22°C was maintained in the vivarium. Two series of experiments have been conducted. In the first experiment, 10 rats out of 30 fasted without water and 10 rats fasted with water until the lethal term. In the second experiment, all animals fasted for 3.5 days (sublethal term). At the end of the experiment, the animals were re-weighed, decapitated, and the obtained blood was cooled down and centrifuged. Malondialdehyde (MDA) content in blood serum was examined. The mass of the rat's liver was measured, and the ratio of liver mass to body weight was calculated.

1.2 Research on volunteers

Six apparently healthy male volunteers aged 29 to 55 fasted for 68 hours under normal temperature conditions (15 - 30°C) in a Tabai thermal pressure chamber (Japan). Prior to the beginning and on the third day of food and water deprivation, all subjects underwent an in-depth clinical and functional examination in a hospital (1st Naval Clinical Hospital). Electrocardiographic, phono- and polycardiographic studies, echocardiography with calculation of stroke and minute blood volumes were conducted. The status of the digestive system was monitored using ultrasound and intragastric pH metering. Psychophysiological studies were carried out using the automated diagnostic complex (*Schuhfried*, Austria) on an IBM PC/AT personal computer.

During the principal test period inside the Tabai chamber, body mass, pulse, blood pressure, and body temperature were measured every 4 hours, and hourly and daily diuresis values were calculated. An ECG was recorded twice a day, followed by a mathematical analysis of the heart rhythm (variational pulsometry). Their patient’s self-reported condition was analyzed, both using the Condition Assessment Cards for Absolute Fasting questionnaires issued before the start of the research, and using objective analysis (in points) of well-being indicators, such as activity level, mood, and anxiety using the standard SAN test and the Spielberger-Hanin scale (every 6 hours).

Somatometric measurements were conducted twice a day, including the calculation of fat and water content, lean and total muscle mass in the body. Every day at 6 a.m., oxygen consumption and carbon dioxide emission were measured in each of the subjects at rest. Respiratory coefficients (total and non-protein) and total body heat production under basal metabolic conditions were calculated. V.P. Mikhailov's equations (1988) and the tables introduced by I.M. Buznik (1983) were

used to determine the amount of metabolized proteins, fats and carbohydrates.

In the pre-fasting period, physical performance was evaluated using the PWC 170 bicycle ergometric technique daily during the absolute fast and after a 7-day restorative nutrition period. Immediately prior to bicycle ergometry, after performing a stress test and after 30 minutes of rest, peripheral blood was collected to determine lactate, pyruvate and glucose levels. When performing the 2nd load stage, the composition of exhaled air was studied using the gas exchange method on the Spirolit-11 (Germany) apparatus. Thus, the body's energy expenditures during intense physical work and the boundaries of the aerobic anaerobic transition were determined.

At the beginning of each day of absolute fasting, blood was drawn from all subjects for biochemical and radioimmunological testing. The composition of peripheral blood was analyzed using a Serono (USA) hematological automatic counter SYSTEM 9000. Biochemical blood tests were performed using a Spectrum II automated diagnostic system from Abbott (USA). The acid-alkali balance was determined on a Radiometer pH and blood gas analyzer ABL 330 (Denmark), plasma osmolarity was determined using the cryoscopic method on a Model 302 osmometer manufactured by Advanced DigiMatic (USA). Radioimmunological studies were used to determine the content of triiodothyronine, thyroxine, thyroid-stimulating hormone, somatotropic hormone, adrenocorticotropic hormone, cortisol, insulin, aldosterone in the serum and plasma.

A reduced coagulogram was performed to evaluate the hemostatic system. Protein fractions in the blood serum were determined by electrophoresis on paper, and medium molecular weight proteins were revealed using spectrophotometry . The content of malondialdehyde and the activity of a key antioxidant enzyme, superoxide dismutase, were studied. Immunological studies (T-, B-lymphocytes, Ig A, M, Q in blood plasma and others.) were conducted. The daily urine content of ketone bodies, nitrogen-containing substances (urea, ammonia, creatinine, etc.) was determined, as well as electrolyte (potassium, sodium, calcium, chlorides, etc.), vitamins (B1, B2, C and PP), and 17-hydroxycorticosteroid concentration.

1.3 Clinical trials

Under clinical conditions, controlled monitoring of 64 patients (50 women and 14 men) undergoing therapeutic fasting (RDT) was carried out. The age of the examined patients ranged from 18 to 55 years. Of these, 50 were women and 14 were men. The indication for RDT was the presence of alimentary and constitutive obesity and various diseases of the internal organs, joints and skin. Among the presented nosological forms were: stage 1-2 hypertension (21 people), chronic asthmatic bronchitis and bronchial asthma (13), chronic gastritis and

gastroduodenitis (10), neurodermatitis and skin allergoses (9), osteochondrosis and deforming osteoarthritis (6). Most patients (60) were overweight and suffered from 1-4 stage obesity.

During the treatment, 39 patients (group 1) underwent traditional RDT (Nikolaev Yu.S., 1969; Kokosov A.N. et al., 1984). 25 patients (group 2) underwent a short absolute (dry) fast (24-72 hours) at the initial stage of the fasting period. The distribution of the observed patients by gender, age, and pre-conditions in both groups was approximately the same. The average duration of therapeutic fasting was 12.8 ± 0.9 days, and the recovery period equaled 7.3 ± 0.5 days. In the pre-fasting, on days 3, 7 and 12 of the fasting period and upon completion of rehabilitation, clinical, laboratory and instrumental studies (blood and urine biochemistry tests, ECG, ultrasound, veloergometry, health surveys, etc.) were carried out at the hospital in accordance with the existing scheme of studying three-day absolute fasts. No intake of any medication was allowed in the RDT process.

In order to introduce absolute (dry) fasting, a new fasting therapy method was developed at the clinic. Following the preliminary intestinal cleansing (siphon enema), patients are encouraged to refrain from food and water intake for 24-72 hours (according to individual tolerance). All water procedures (baths, showers, enemas, etc.), physical activity are prohibited during this period. Laxatives are not utilized. At the end of the dry period, patients continue to fast according to the usual RDT technique, limiting water intake to 10-12 ml/kg per day. Daily cleansing enemas, baths, showers, massage, walks, physiotherapeutic procedures and therapeutic exercise therapy are prescribed. During the recovery period, the diet corresponds to the usual RDT schemes and is based on gradual increase of the amount and variety of food. Artificial nutrition mixes were used at the rehabilitation stage, after three days of absolute fasting.

The results of the studies were processed using common statistical methods and the Statgraphics application package on IBM PC/AT.

2. The three-day absolute fasting evaluation results

2.1. Studies on laboratory animals: results

As a result of experimental studies performed on laboratory animals, the difference in life expectancy with regular (wet) and absolute fasting was found to be insignificant ($p>0.05$): animals remained alive with only water intake for 7.2 ± 0.3 days, without water or food – for 6.9 ± 0.5 days. Total weight loss amounted to

36.6 ± 1.5 (g) with absolute fasting (20% of the initial mass), and 24.5 ± 4.46 (g) with regular (wet) fasting (12%). The obtained experimental data demonstrated the relative safety of three-day absolute fast (weight loss of under 20% of the initial weight; the absence of pronounced intensification of lipid peroxidation). The foregoing was the basis for conducting physiological studies of 3-day absolute fasting on apparently healthy male volunteers.

2.2. Studies on volunteers: results

As a result of the study, it was determined that three-day absolute fasting under ordinary temperature conditions (15-30°C) does not lead to a pronounced metabolic disorder or to significant dehydration of the body. The total fluid deficiency in the first 3 days does not exceed 2-4%, which corresponds to a mild degree of dehydration. As a result of respiratory energy measurement, it was found that the elimination of water from the body is only responsible by 40% of the total weight loss. 30-40% of the total loss is accounted for by inactive adipose tissue, 15-20% - by the decrease in lean mass (mainly glycogen). Loss of plasma and muscle proteins does not exceed 1-3%. Physiological oliguria (diuresis up to 400-500 ml/day) and a decrease in cutaneous/pulmonary perspiration to 30-40% of the initial level contribute to a decrease in water consumption.

Absolute (dry) three-day fasting leads to a typical bodily stress response. Blood cortisol concentration increases by 30% compared to the initial level, while the daily excretion of steroid hormones with the urine increases. An increase in the activity of contrainsular hormones leads to a significant decrease in insulin production in the pancreas. Blood insulin concentration decreases by 60% by the third day of fasting, which is a protective reaction of the body to a lack of carbohydrates. There is a decrease in the functional activity of the thyroid gland, and triiodothyronine concentration in blood plasma is reduced by 25%.

These changes should also be considered adaptive, as they lead to a decrease in energy expenditure and bodily heat loss under the conditions of basal metabolic rate. The blood aldosterone content increases by 87% after 56 hours of fasting. The production of aldosterone and antidiuretic hormone caused by the absence of water enhances the reabsorption of water and electrolytes and minimizes the loss of fluid and mineral salts by the body.

The main mechanisms of the body's endocrine and metabolic adaptation to the absence of food and water are as follows: 1) decreased basal metabolic rate and total energy expenditure; 2) metabolic switch to endogenous nutrition of the predominantly fat type; 3) formation of endogenous water during the oxidation of bodily substrates; 4) decreased diuresis and perspiration.

The endocrine and metabolic adjustments that take place under these conditions are adaptive and do not lead to a pronounced metabolic disorder or significant dehydration of the body. The examined dynamics of the functional state of the vital body systems (cardiovascular, digestive, etc.) is positive in many cases and indicates an adequate reaction of the body to the absence of incoming food and water. There is a decrease in stroke (by 15%) and minute (by 18%) blood output. Meanwhile, the study of the cardiac cycle's phase structure shows that contracting activity becomes more effective. The myocardial tension period is reduced by 22%. The ejection fraction increases from 48 to 50%. Electrocardiography and pulsometry data do not indicate a disturbance in the heart rhythm and a deterioration in blood supply and myocardial trophism.

2.3. In-patient 1-3 day absolute (dry) fast

In recent years, traditional (wet) therapeutic fasting has been successfully used in clinical settings to reduce excess body weight in patients with alimentary-constitutive obesity. The results we obtained at the previous stage of the study indicate that three-day absolute (dry) fasting is not dangerous to human life and health. This allowed us to test the possibility of using 1-3 day absolute fasts in the treatment of patients with certain cardiovascular diseases (neurocirculatory dystonia, 1 and 2 stage hypertension).

Using a combination of absolute 1 to 3-day fast and a subsequent wet fast (about 10 days), we were able to achieve an earlier and greater normalization of weight. The reduction of patient body weight over 12 days of traditional RDT (with unlimited water intake) is 7.46 ± 0.3 kg (0.62 kg/day), and with absolute and wet fasting, it amounts to 8.62 ± 0.35 kg (0.71 kg/day), where differences are statistically significant ($p<0.05$). Body weight in patients who limit fluid intake to 10-12 ml/kg per day decreases by 10.2 ± 0.4 kg (0,85kg/day) at the end of RDT. Greater water intake restrictions during fasting are impractical, because they lead to thirst and are poorly tolerated by patients.

Apparently, absolute fasting is superior to regular (wet) fasting in therapeutic effectiveness. Abstinence from water intake for 3 days corresponds to 7-9 days of regular RDT. It is precisely at this time that the acidotic crisis sets in, or, in other words, the endocrine/metabolic switching to endogenous nutrition occurs. Dry fasting, used in an integrated fasting therapy complex, leads to an earlier and more complete utilization of bodily fat deposits. Faster normalization of blood pressure is observed in patients with stage 1–2 hypertensive disease. The average systolic

pressure on day 7 of RDT are 148 ± 16 mm Hg with wet fasting and 117 ± 8 mm Hg with absolute fasting ($p<0.05$), and diastolic blood pressure - 115 ± 12 mm Hg. and 86 ± 9 mm Hg, respectively ($p<0.05$). Stabilization of blood pressure indicators at values corresponding to the age norm occurs in the majority (90.2%) of patients undergoing traditional RDT technique by day 6.2 ± 1.6, and with 1 to 3-day absolute fasting – by day 3.1 ± 1.2. Antihypertensive drugs are discontinued from the first day of therapeutic fasting.

In general, all patients tolerate RDT treatment satisfactorily. The acidotic crisis, which occurs on day 3.5 ± 1.5 of an absolute fast and on day 7.1 ± 2.5 of a wet fast, clinically manifests itself as a slight deterioration in well-being (from 5.4 ± 0.2 to 4.9 ± 0.7 on the SAN test (a survey of patients' subjective sensations), transient headache, drowsiness during the day and disturbance of night sleep, less frequently – nausea. Exercise tolerance on a bicycle ergometer (PWC 170 test) decreases on day 7 of wet fasting from 144 ± 15 (W) to 103 ± 9.4 (W), and with absolute fasting – from 160 ± 18 (W) to 99 ± 9.3 (W). Mental performance test results demonstrate unreliable changes.

In a biochemical blood serum test after 7 days of RDT, a significant decrease in the glucose (from 4.9 ± 0.2 to 3.8 ± 0.1 mmol/l) and urea content in the blood (from 5.3 ± 0.3 to 4, 4 ± 0.4 mmol/L). On the 12th-14th day of fasting, enzymatic activity increases, indicating active ongoing gluconeogenesis. A decrease in the blood potassium level is noted (from 4.3 ± 0.13 to 3.9 ± 0.10 mmol/L) starting on the 7th-12th day of the fasting period, which sometimes requires additional medication. When comparing the dynamics of the main biochemical blood parameters of patients during wet and absolute fasting on the 7th and 14th days of RDT, the differences are statistically unreliable. When a dry 1 to 3-day fast is prescribed at the beginning of the fasting course, a higher indirect bilirubin and total cholesterol content is noted. Signs of blood thickening (total protein, hemoglobin to hematocrit indicators) do not exceed 3-4% (during wet fasting) and 4-6% (during absolute fasting).

Long-term treatment results were monitored by a survey. Over 80% of respondents note the persistent positive effect after a fasting therapy course. In 17.5% of patients, symptoms of the underlying disease reappeared within 2 to 6 months after completion of the RDT, requiring the resumption of medication intake, but at lower doses than before. The number of such patients in both groups (wet and absolute fasting) was the same. After completing inpatient treatment, all obese patients received recommendations to conduct a weekly 24-hour dry fast on an outpatient basis. Following dynamic observation, body weight stabilized in most

patients with alimentary-constitutive obesity (58%), while in 14% it continued to decrease.

CONCLUSIONS

1. A three-day absolute fast under ordinary temperature conditions (15 - 30°C) does not lead to marked metabolic disturbances and significant dehydration of the body in healthy or ill people between 20-50 years of age. However, all the examined patients demonstrated functional adaptive changes: the metabolism was restructured from predominantly carbohydrate to fat type, which is accompanied by subcompensated ketoacidosis, hyperbilirubinemia and inhibition of enzymatic activity. A significant decrease in basal metabolic rate and physical performance is observed in this context.

2. Complete deprivation of the body of food and water leads to a decrease in stroke and minute blood volume. In patients with 1 and 2 stage hypertension, stabilization of blood pressure indicators at values close to the physiological age norm is observed after 3 days of fasting.

3. The greatest metabolic changes occur in the hepatobiliary system, manifesting in the deceleration of enzymatic processes of glucuronidation of bilirubin, glycolysis and synthesis of urea in the liver by the 3rd day of absolute fasting, and the rapid disappearance of the main glycogen stores. At the same time, there is a slight increase in the size of the gallbladder and the content of biliary sediment in its lumen.

4. Changes in the main components of the body macrostructure during an absolute 3-day fast are manifested in the predominant utilization of glycogen and deposited fat reserves for plastic and energy needs with minimal expenditure of water, and plasma and muscle proteins. Gradually developing hypertonic dehydration does not exceed a mild degree and is accompanied by an increase in the ketone body levels, lactate, pyruvate, and plasma osmolarity with stable levels of basic blood electrolytes (sodium, chlorine, calcium).

5. Neuroendocrine realignment in the body due to a complete absence of food and water manifests in a significant decrease of insulin secretion due to increased activity of contrainsular hormones (cortisol, etc.), which is the most important adaptive mechanism that contributes to the rapid transition to endogenous nutrition and water production during the oxidation of

glycogen and deposited lipids. The decrease in the production of thyroid-stimulating hormone and triiodothyronine leads to a significant decrease in the basal metabolic rate, and, consequently, the energy expenditure and heat loss of the body. Under the influence of antidiuretic hormone and aldosterone, facultative reabsorption of water and electrolytes increases, thus, the loss of fluid and mineral salts by the body is minimized.

6. The severity of the condition of patients after prolonged alimentary and water deprivation is determined by the severity of the general bodily dehydration and, to a lesser extent, by the fasting factor. In thermoneutral conditions and after an absolute 1-3 day fast, the severity is characterized as mild.

7. The use of short (1-3 days) absolute (dry) fasting at the initial stage of therapeutic fasting allows for greater reduction in body weight in patients with obesity, early normalization of altered blood pressure indicators, and a more pronounced therapeutic effect in the treatment of patients with bronchial asthma, chronic asthmatic bronchitis, skin allergoses, chronic gastritis and gastroduodenitis, metabolic arthropathies. An early onset of the ketoacidotic crisis (on day 2-3) allows to complete the endocrine and metabolic restructuring of the body to endogenous nutrition faster and reduces the time of in-patient treatment.

PRACTICAL RECOMMENDATIONS

1. The rehabilitation of patients who experienced prolonged food and water deprivation (2 days or more) should begin with the oral administration of 5-10% solutions of glucose, sweet tea, non-concentrated fruit and vegetable juices, and slightly alkaline mineral waters. The volume of injected fluid is calculated based on the severity of the condition:

   mild condition: 20-30 ml/kg body weight per day,
   moderate severity: 40-50 ml/kg per day,
   severe cases: 70-100 ml/kg per day.

2. Restorative nutrition should be prescribed 6-12 hours after the start of treatment with liquids. On day 1-3 of rehabilitation, the use of artificial nutrition mixtures is recommended:

   mild condition: 1.5-2 liters of ready mixture per day,
   moderate severity: 2-3 liters of ready mixture per day,

severe cases: 4-5 liters of ready mixture per day.

Fresh fruits (apples, citrus fruits, etc.) and vegetables (tomatoes, cucumbers, cabbage, carrots, etc.), fruit and vegetable juices (with pulp) are also recommended. The recovery diet is gradually expanding with the inclusion of buckwheat, rice, wheat porridge (water-based, with no salt) and bread (from day 4-5), vegetarian soups (from day 6-7), with the transition to the regular daily diet by day 10-15 of rehabilitation.

3. A short-term in-patient absolute (dry) fast is possible only in the initial period (day 1-3) of fasting therapy (RDT). After preliminary intestinal cleansing (siphon enema), patients simultaneously stop taking food and water (for 24-72 hours) and exclude any water procedures (baths, showers, enemas, etc.). After the period of absolute fasting is over, patients are treated according to the usual RDT regimen, limiting water intake to 10-12 ml/kg per day. The therapeutic effect is observed in the treatment of patients with stage 1-2 hypertension, chronic asthmatic (obstructive) bronchitis and bronchial asthma, chronic gastritis and gastroduodenitis, metabolic arthropathy, skin allergies, especially with a combination of these diseases, concomitant alimentary-constitutive obesity and predisposition to edemas.