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Evaluation of physical state of patients with mandibular fractures via bioimpedans ometry

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Abstract: During the immobilization of the jaws, the weight of the injured decreases significantly, it progresses nutritional insufficiency. The trophological status of patients with fractures of the lower jaw was evaluated by means of bioelectrical tissue impedance. Deviations from ideal body weight were found in 47% of cases, body mass deficiency was noted in 24% of patients, propensity to nutritional insufficiency, increase in fat mass was observed in 23%. For such patients, an excess body weight with a higher content of muscle tissue is optimal, which during the immobilization period supports the body and serves as a depot for posttraumatic catabolism, preventing a nutritional deficiency. Patients need to carry out rehabilitation measures aimed at correcting body weight, increasing muscle tissue, which will strengthen their health, prevent the progression of weight loss and the development of complications.

Key words: jaw fracture, jaw injury, bioimpedansometry, nutritional status, body composition.

Research rationale.

In the past decade there has been a significant increase in injuries due to industrialization and changes in social and economic conditions [1,13]. Injuries of the maxillofacial area is a significant social problem, since the majority of such victims are people aged 20-40 years who are the most able-bodied part of the population. In connection with this, the treatment and rehabilitation of this contingent of patients acquires not only medical but also great social significance.

As analysis of the literature shows, the methods of diagnosis, qualified care for patients with traumas of the facial skeleton are constantly improving. At the same time, to the rehabilitation of patients with regard to their nutrition is not given enough attention, so rehabilitation of

patients with trauma of the facial skeleton bones remains as an actual problem. It is shown that in the period of immobilization there is a expressed nutritional insufficiency, which causes complications, a decrease of immunity, which slows wound healing and consolidation of fragments. As a consequence, the period of temporary incapacity of patients is prolonged, and later the quality of life violates in patients with a jaw fracture [1,12,14,15,18].

Under the influence of trauma and stress catabolism, consumption of proteins, fats, carbohydrates, vitamins, salts increases, metabolism is disrupted. Bimaxillary bonding of the jaws is one of the causes of alimentary fasting, eating disorders of the patient. As a result of restriction in food and other adverse factors, occur secondary somato-endocrine disorders, and the body weight decreases in the post-traumatic period. Somato-endocrine disorders not only cause persistent social disadaptation of patients with jaw fractures, but also pose a direct threat to their lives. According to some authors, even on the background of additional nutrition, these patients have a negative dynamics of trophological status. According to the definition of I.E. Khoroshilov (2003), under malnutrition means a pathological condition caused by a mismatch in the intake and consumption of nutrients, leading to a decrease in body weight and changes in the body composition of the organism [20].

Specialists who study the physical status of a person consider the body mass of a person as one of the main indicators of physical health, as it, in their opinion, represents an integral assessment of energy and information exchange processes degree occurring in the body.

In preventing an adverse outcome in the treatment of patients with injuries, physical health and nutritional status are of great importance. It is known that health is determined not only by the presence or absence of diseases, but also by harmonious development, the normal level of the basic functional indicators. The complex concept of physical condition includes such factors as health, physical development, body weight, strength, muscular power, coordination of movements, motivation, etc. Human health is influenced by the environment, socio-economic factors, working and living conditions, nutrition, physical activity, playing sports [2,3,13].

Modern approaches allow us to more deeply study the composition of body weight, using different levels of organization of the biological system, such as atomic, molecular, cellular, organ-tissue and organismic [13].

Thanks to the development of modern technologies, the method of bioimpedansometry, a method that allows to determine the nutritive status and composition of a human body using the measurement of the electrical resistance (impedance) of its tissues is widely used in scientific research and in practical public health. The tissues of the human body are capable of conducting electric current. Bioimpedance analysis makes it possible to assess the parameters of the organism much deeper and wider than it can be done with conventional anthropometry. Liquid medium (water, blood, the contents of hollow organs) have a low impedance, i.e., conduct a good current, and in more dense tissues (muscles, nerves, etc.) the resistance is much higher. The largest impedance is in fat and bone tissue [2,4,6,15]. Bio-

impedance measurement will allow the modern doctor to correctly interpret the indicators of physical status, as well as differentiate early manifestations of nutritional insufficiency, which will provide a more favorable outcome of the underlying disease.

The objectives of the study is the timely detection of abnormalities of physical health for the further correction of rehabilitation measures, which allows raising the level of health and preventing nutritional insufficiency of patients with jaw fracture.

Materials and methods of the study

Under supervision were 78 patients with fractures of the lower jaw at the age of 18 to 55 years. The study was conducted in of Adult Surgical Dentistry Department of the Tashkent State Dental Institute and in the Department of Emergency Maxillofacial Surgery of the Emergency Clinical Hospital

Table 1 . Characteristics of patients with fractures of the lower jaw

Unilateral fracture of the lower jaw				Double fracture	Bilateral fracture	Multiple fracture	Total
angles	bodies	Articular process	Alveolar process	In the body			
18	12	14	2	19	12	1	78

In all patients, anthropometric parameters such as height and body weight were determined on the basis of which the body mass index (BMI) was calculated according to the formula: I = m / h2, where: m - body weight in kg, h - height in m2. The result was expressed in kg / m2 [2,6,8,13]. According to the WHO classification, the BMI <18.5 kg / m2 is considered as chronic energy insufficiency (HEN), the BMI index <18.5-16 kg / m2 - as a body mass deficit, the BMI index <16 kg / m2 - as a expressed deficit. The upper limit of the normal body mass index is a threshold of 25.0 kg / m2 [8,13]. Patients with abnormalities of body mass index (37) were divided into two groups: 18 people with a deficiency of body weight and 19 with increased weight and obesity. In 41 patients, weight - growth rates were normal.

All 78 patients, except of anthropometry, underwent an examination to assess the segmental bioelectrical tissue impedance by the Tanita BC 545 analyzer (Japan), on the 1st and 2nd days after admission. Were examined: the total volume of water (TVW,%), the mass of mineral substances (kg), the body fat mass (%), the mass of skeletal muscles (MSM, kg), the percentage of fat mass in the body (%), the basal metabolism (BM, kcal)).

Lean body mass (LBM) is mixture of water and minerals, protein in the muscles, serving as its main reserve. Skeletal musculature averages 30% of LBM, 20% of visceral organs, 7% of bone tissue. Reduction of LBM indicates the predominance of catabolic processes over anabolic, i.e. is a sign of the development of the syndrome of hypermetabolism or protein-energy deficiency. Fat mass is necessary for the body as a store of energy, vitamins and fatty acids, which take part in vital processes. Working capacity decreases, at higher or lower rates of it. The basal metabolism correlates with the

values of the cell mass, the low level of which indicates to malnutrition. The physical evaluation of bioimpedance is considered by scientists as a quantitative indicator of the condition, muscle performance and metabolic rate of the individual.

The results we obtained were processed with the help of variation statistics methods using computer programs Statistica 6.0, Microsoft Office Excel 2010. The statistical significance of the mean values of independent samples was estimated using the Student's parametric criterion and the Fisher's nonparametric criterion depending on the type of distribution of the indicators. Differences in mean arithmetic values were considered significant at 95% ($p < 0.05$) of the threshold of probability.

Results of the study and discussion

Body weight in patients with fractures of the lower jaw ranged from 42.6 kg to 103 kg, an average of 69.6 ± 1.42 kg. The body mass index was on the average 23.0 ± 0.4 kg / m2, which corresponded to the norm. This indicated a predominance among the examined people, patients with normal body weight. Obesity of the 1st degree according to the WHO classification was revealed in 6.2% of patients, excess weight was in 17.3%, normal in 53%, low body mass index was registered in 23.5%. The average age of patients with underweight was 23 ± 1.0 years, with a normal body mass index of 32.6 ± 2.2, with an overweight of 35.0 ± 1.7 years, with obesity of the 1st degree - 29, 5 ± 1,5 years.

Table 2. Characteristics of bioimpedanceometry parameters depending on the body mass index in patients with lower jaw fracture s, M ± m

Options	Indicators of body mass index (BMI) , kg / m ^{2}		
	<18.5	18.5-24.9	> 25
	n = 18	n = 41	n = 19
Body weight, kg	55.0 ± 2.66	65.3 ± 0.95 **	85.6 ± 2, 54 ^^^
BMI , kg / m ^{2}	18.2 ± 0.08	21.8 ± 0, 28 ***	27.9 ± 0, 66 ^^^
Fat mass%	11.0 ± 1.56	1 6 , 2 ± 1.22 *	21.6 ± 1, 16 ^^
Muscular mass , kg	47.1 ± 1.76	51.1 ± 1.40 *	63.6 ± 1.82 ^^^
Total liquid ,%	65.2 ± 1.65	58.1 ± 1 , 85 *	5 2.2 ± 3.12
Basic metabolism , kcal	1486.45 ± 22.29	1 613.9 ± 2 8 , 12 * *	1963 , 2 ± 51.6 ^^^
physical rating , score	5.2 ± 0, 66	4.9 ± 0, 2 3 *	3.4 ± 0.4 3 ^^
Bone mineral mass	2.5 ± 0.09	2.8 ± 0.05	3.3 ± 0.09 ^^^
Systolic blood pressure, S BP,mm p m. Art.	108.3 ± 5.1	11 7 , 1 ± 6.1	12 8 , 9 ± 8,5 ^^^
Diastolic arterial pressure , DBP, mm Hg . Art.	77.4 ± 6.4	79.87 ± 5.1	85.5 ± 7.6
Pulse , h / min	71.7 ± 5 , 6	72.5 ± 7, 1	82.5 ± 8.0 ^^^

Note. * - significant in comparison with the indices of patients with a lowered BMI (* - p <0,05; ** - p <0,01; *** - p <0,001). * - significant compared with the indices of patients with normal BMI (^ - p <0.05; ^^ - p <0.01; ^^^ - p <0.001).

In patients with a BMI <18.5 kg / m2, most of the anthropometric and bioimpedanceometric parameters were statistically significantly less than in patients with normal BMI (18.5-24.9 kg / m2) on a background of higher relative muscle mass and percentage the content of fluid in the body. With a decrease in body weight or fat mass below a certain level, both work capacity and health suffer. In all patients with a low body mass index, is revealed a lack of mineral substances, mass of skeletal muscles and adipose tissue. Lower (in 1.5 and 2 times) absolute and relative fat mass in patients with body weight deficiency may indicate a decrease in lipid-soluble vitamins, fatty acids in the body and a decrease in energy depot. Significantly low absolute values of muscle and fat mass, basic metabolism of body, indicate to malnutrition in patients with body weight deficiency.

In half of patients with a normal body mass index, the ratio of the mass of skeletal muscles and adipose tissue is optimal, the rest of the examined group showed a lack of muscle mass of 2-24 kg with a lack of minerals. Among patients with excessive body weight and obesity of the 1st degree, body weight without taking into account fat and the content of mineral substances, were almost identical. Attention is drawn to the fact that the maximum content of fat and lean tissue, basic metabolism was in patients with excessive body weight.

Water plays a vital role in many processes occurring in the body, and is a part of cells, tissues and organs. Maintaining a normal total percentage of water in the body ensures the proper functioning of all body systems and reduces the risk of health problems [2]. A high volume of the total fluid in the body was recorded in patients with a reduced body weight with underlying higher percentage of it. The total percentage of water in the body of healthy men varies from 50 to 65%, in patients with overweight, this figure remained at the lower limit of the norm - 52.2 ± 3.12 ($p \leq 0.01$).

The more active the physical exercise, the more muscle mass increases and, accordingly, the higher the percentage of lean mass. The metabolic response to trauma and stress is qualitatively different from that observed in simple starvation, when a gradual reduction in energy expenditure and a decrease in glucose synthesis allow fat to become the main energy producing substrate, and also to save protein stores for the body. Post-traumatic catabolism leads to the catabolism of skeletal muscle proteins to amino acids with enhanced oxidation of amino acids [16,17]. During immobilization, the body weight of patients decreases with a decrease of muscle mass, as a result of which cell nutrition and the functions of internal organs are violated. It is important that the body weight of patients is preserved or decreased by fat mass, so care must be taken to ensure that the loss of lean mass is maintained at about the same level. This requires an increased intake of protein with food, which is not equivalent to increasing the caloric content of the diet [4,12].

Fat mass of the body reflects the physiological characteristics of the

organism, the adaptation of the organism to the natural and social environment. With age, the normal percentage of fat rises and in normal men is 15-19 years 10-20%, 20-39 years - 8-20%, 40-59 years - 11-22%, over 60 years - 13-25% [3,10,13]. Fat tissue is necessary for the body: it is a store of energy, vitamins and fatty acids, which are participants in vital processes. Fat cells perform protective and thermal-insulating functions, accumulate and synthesize some hormones. That is why the body actively protects its fat stores (for example, muscle mass due to catabolic reactions is split more easily and faster than fatty, and this is the main danger of rapid weight loss). Thus, the evaluation of fat mass makes it possible to judge the depot of the body's energy, lipid-soluble vitamins (A, D, E, K) and the risk of atherosclerosis and / or myocardial infarction [6]. Among the patients we observed with fractures of the jaw, the smallest part was made up of individuals with excessive body weight (17.3%) or obesity (6.2%). This integral index of the body in patients with jaw fractures with excess body weight was significantly higher than in others ($p < 0.001$), which corresponds to the literature data.

The indicators of lean mass allows to assess the parameters of the basic metabolism, energy consumption and calculate the daily diet. The basic metabolism correlates with the parameters of the cell mass, the decrease of which indicates to malnutrition.

The basic metabolism is one of the indicators of the intensity of metabolism and energy in the body; is expressed by the amount of energy necessary to sustain life in a state of complete physical and mental rest, in conditions of thermal comfort. Reflects the energy expenditure of the body, providing the permanent activity of the heart, kidneys, liver, respiratory muscles and some other organs and tissues. The energy released in the course of metabolism is used to maintain a constant body temperature. The BM value is usually expressed as the amount of heat in kilocalories (kcal) or kilojoules (kJ) per 1 kg of mass or 1 m2 of body surface per hour or 1 day. The value or level BM depends on the person's age, body weight, sex and some other factors [2]. The BM value for a man with a body weight of 70 kg averages about 1,700 kcal per day (1 kcal per 1 kg of mass per hour). According to our results, the calculated BM value in the examined patients on the average corresponded to $1\,595.1 \pm 50.34$ kcal, which is 8% lower than the due value and is within the permissible normative ranges (up to 10%) for healthy people. In the post-traumatic period, patients with fractures of the jaws are observed metabolic disorders, increases the need for nutrients, i.e. there is nutritional imbalance. In this case, the daily intake of calories required to provide basic metabolism and metabolism increases by 35-40 kcal per 1 kg of weight [17]. In patients with a jaw fracture with a body weight deficiency, the BM value was 1486.45 ± 22.29 kcal, i.e. was below the norm, which indicates the prevalence of anabolic processes in the body, and in patients with an excessive body weight BM was 1963.2 ± 51.6 kcal ($p < 0.001$), which indicates a reduced physical exertion.

The parameters of physic rating of bioimpedance is considered by scientists as a quantitative indicator of the condition, muscle capacity and metabolic intensity of an individual [13,19]. Physical

assessment had significantly higher values in patients with normal and decreased body weight, which indicated higher significance of their physical working capacity.

Lack of mineral bone mass may be a sign of osteoporosis, the structural damage of bone tissue, which leads to an increased risk of fractures [8-11]. Often, this condition is observed in unbalanced food with a deficiency in the diet of calcium, magnesium and certain vitamins, as a result of a sedentary lifestyle, with metabolic disorders, diseases of the gastrointestinal tract. The likelihood of developing osteoporosis also increases with excessive or insufficient body weight. Calcium is the main structural element of bone tissue, so the deficiency of this microelement leads to a decrease in the proportion of bone mass in the body. Although a noticeable change in the structure of bone tissue in a short period is unlikely, it is important to strengthen and maintain its condition through a balanced diet and considerable physical exertion [2,7].

Some authors point out the existence of a association between the physical status and cardiovascular performance indicators - heart rate (HR), systolic (SBP) and diastolic (DBP) arterial pressure [2,5].

The correlation coefficient between BMI and SBP in patients of the 3 groups was, respectively, r = 0.26; 0.28; 0.37 (p = 0.001); BMI and DBP - r = 0.19; 0.26; 0.34 (p = 0.001) to the groups. These data indicate the presence of a direct association between hemodynamic indicators and the body mass index. Meanwhile, in patients with fractures of the mandible, this relationship between the indicators of excess BMI and SBP was more expressed than between normal hemodynamic parameters and decreased BMI. The close association of BMI with SBP is indicated by other authors too [2,5]. Observed by us the specificity of contingency of somatic and hemodynamic parameters associated with anthropometric parameters allows us to conclude that SBP is a marker of the cardiovascular system regulatory mechanisms exertion when it is an increased BMI in patients with a jaw fracture. Lower physical capacity also determines the ability to perform physical exertion, the fulfillment of which depends on different systems of the organism.

Conclusions

1. In the majority of patients at the age of 20-30 years, the average weight - growth rates were within the lower limit of the norm, and one in four patients were below the maximum permissible values. On bioimpedance examinations, divergentions from ideal body weight were found in 47% of cases, body mass deficiency was observed in 24% of patients, a tendency to nutritional insufficiency, an increase in fat mass was found in 23%, since these persons are at risk of frequent exacerbations.

2. On patients with fractures of the mandible, it is necessary to carry out rehabilitation measures aimed at correcting body weight, increasing muscle tissue and basal metabolic indexes, which will strengthen their health, prevent the progression of weight loss and the development of various complications. For this purpose, at the stage of rehabilitation, in addition to therapeutic physical culture and the prescriptions of a balanced diet, it is necessary to carry out activities aimed at improving the functional and physical condition.

3. Bioimpedance analyses of the human body composition will allow the modern doctor to correctly interpret the indicators of physical status, as well as differentiate early manifestations of nutritional insufficiency, which will provide a more favorable outcome of the underlying disease. The change in bioimpedance ometric parameters in the post-traumatic period has a prospect for further research.

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