Energy Optimization

Our organs and all and each of their constituent cells require an uninterrupted flow of matter and energy to ensure maintenance, repair and/or expansion of our bodily structures and, in turn, to provide the required energy for all "active" components of our organs to carry out their corresponding functions.

While carbohydrates, lipids and proteins, ultimately produced by plants, are those that provide the "life energy" that we need they do not have, by themselves, the ability to run directly our organs and systems. All the energy supplied by food must be transferred first to a universal composite present in all cells, known as adenosine triphosphate (ATP), the only compound directly usable as an energy source.

Adenosine triphosphate, or ATP, is used to perform two types of work: one internal, that we do not perceive directly but allows us to experience the sensation of well being and another of external character, manifested as the ability to move, perform daily living and professional activities or practice some kind of sport. The amount of energy used, usually in the first process (the "inside work") is much higher than that spent in the second (the "external work") associated with daily activity or exercise. Being ATP the only compound capable of being used "directly" as a source of energy by our cells, it is surprising that its concentration in the same (particularly, in the muscles) be so minimal that requires the need for appropriate mechanisms for its regeneration in the same amount and pace with which is being used. .

When performing a physical exercise, muscles have three main substrates to regenerate the adenosine triphosphate (ATP) that is spent in the process of contraction:

1. - There is a small amount of a compound endowed with the same energy value as ATP called creatine phosphate (or fosforilcreatine) that allows the regeneration of ATP with maximum speed and intensity. This compound is used in the first seconds of a supramaximal type effort and every time that the exercise requires an increase in the pace of the work that is being done.

2. – Our body can obtain the energy necessary for physical exercise from glucose, of which it has significant quantities stored as glycogen in the liver (about 80 grams) and in the whole of muscles (300 to 500 grams, depending on the degree of training and type of diet followed by the athlete).

Glucose released from such reserves can be used in two ways: by degradation to lactic acid when there is no adequate oxygen supply, in which case only a little over5% of the potential energy of glucose is being used and, moreover, leaves a “contaminant” residue, lactic acid, which disrupts the normal development of muscle activity and quickly leads to muscle fatigue.

When oxygen supply is appropriate to the intensity of the effort being made, the muscles can obtain 100% of the potential energy of glucose through its complete oxidation to carbon dioxide and water (two “non contaminant” compounds). It has been known for many years that the greater the muscle stores of glucose (as glycogen) the best will be the athletic performance and greater the endurance time to fatigue. However, one must bear in mind that the glycogen stores are relatively limited and, furthermore, when a certain degree of reduction in the content of this polysaccharide is reached an exponentially increases in the perception that exercise requires each time more "mental" effort, a fact that may result in a decreased ability to maintain the desired pace.

3. - Unlike the limited energy reserves as glycogen, our body energy reserves are much higher in the form of triglycerides (or fat) from which the muscles can obtain the corresponding fatty acids to be oxidized to carbon dioxide and water (obtaining per gram of fat a quantity of energy over two times higher than that provided by one gram of glucose). Most of the triglyceride reserves are in the subcutaneous adipose tissue, with an uneven distribution in the body, and to a lesser extent, in the abdomen, as part of the so-called visceral fat.

In the form of triglycerides our body can store from 10 to 15, 20, ... kg with a potential reserve of energy of the order of 90.000, 135.00, 180.000, .. kcal (compared with the 1.200 to 2.000 kcal that can provide the muscle the glycogen stores). However, this system which is "extensive" (much potential energy distributed over extensive areas of our body) is very little "intensive" in the sense that it can not supply large amounts of energy per unit time and, moreover, it releases it at a very slow pace. Thus, the fat (and their corresponding fatty acids) stored in the subcutaneous adipose tissue and / or visceral fat, by itself, satisfies only the energy requirements associated with efforts of low to moderate intensity.

On the other hand, it has been found that when the intensity of effort is higher than 25-30% of the maximum, the fatty acids released from adipose tissue, can not explain the total amount oxidized by the whole musculoskeletal system. This fact has forced to seek other sources and led to the discovery that, in the muscle or cell fibers themselves there is a significant reservoir of fatty acids (in the form of fat droplets) that can vary between 400 and 500 grams (with a total energy potentially available, of the order of 3500-4500 kcal, significantly higher than that available in the form of glycogen). This type of Intramuscular fat, in addition to being located in the muscle fibers themselves, has the advantage that fatty acids are made available immediately, without the delay which involved in the stimulation, release, transport, ..., processes that are required in the mobilization of the reserves present in the adipose tissue.

Such triglycerides, known as "intramyocellular" fat, can be used in a significant proportion in intensity efforts up to 85% of the maximum. It is estimated that in a football game, this source of fatty acids may contribute up to 50% of the energy consumed during the competition allowing therefore to spare muscle glycogen for the moments of greatest intensity and to maintain the sense of well being for more time (it is known that the perception of effort is inversely related to the concentration of muscle glycogen and when this is reduced below a critical value, the feeling that the exercise is becoming harder and heavier increases exponentially).

In order to get the fat droplets, present in the muscle fibers, to reach the maximum possible size, it has been observed that the ingestion of an adequate amount of dietary fat (like that present in almonds), preferably about 60 to 90 minutes before a game or competition, allowing to have a “locally” higher fatty acid reserves at the time of initiating the effort and, at the same time, if one continues to furnish, slowly but steadily, approximately, every 20 to 40 minutes, fatty acids absorbed from the intestine (as these are the preferred ones over those that can come from other sources), the muscle fatty acid droplets can be kept in an acceptable size along the whole exercise.

Dr. Ramon Segura Cardona

www.fisiologiadeportiva.com