TRANSFORMATION

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Dr. Mamadou's teaching and research activities have been in the areas of protein chemistry, enzymology, food sciences and technology, cell and molecular biology, environmental health, biomedical engineering, and biotechnology. He has taught and conducted research at several universities and has provided consulting and research services for various industries in product development, environmental toxicology, and functional foods as dietary supplements. Dr. Mamadou continues to be actively involved in health prevention research dealing with various nutritional disorders, degenerative diseases, and the identification of health risk biomarkers.

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STRESS AND DIGESTIVE FUNCTION

Emotional and psychological influences constitute some of the main factors that overwhelm the human digestive system in today's society. These can include anger, anxiety, fear, type A personality, the loss of a loved one, strained or failed relationships, unemployment, overwork ("too much to do in not enough time"), financial pressures, and various other factors. Contrary to the biological systems of many other animals, our stress is largely self-induced. Humans tend to over-speculate the scope of their worries and/or exaggerate their stressful realities. This tendency creates a chronic stress response that will lead to the weakening of the body. This weakening process starts with the inability to digest, absorb nutrients, and meet one of the body's main needs-nutrient acquisition.

The body's biological responses to stress include stimulation of the autonomous nervous system (particularly the sympathetic system) as well as secretion of various stress hormones such as adrenaline, noradrenaline, and cortisol. The purpose of this response mechanism is to help the body either fight off or flee from the stressful event. In doing so, several of the biological functions that may hinder this "fight or flight" response are inhibited. Under normal conditions, when the stressor agent is removed or controlled, the various stress-induced hormones return to their baseline levels. This return to normal removes the inhibitions created by the stress. Thereby, other body functions are optimized.

As reported in earlier editions of *Dr. M's Science Notes*, nutrient acquisition constitutes a fundamental requirement for life, vitality, vigor, and good health. Several factors can impair the proper acquisition of nutrients to the cells. One of these factors is chronic stress. According to Selye, stress is the nonspecific response of the body to any demand made upon it. Chronic stress refers to a condition wherein one is predominantly or even constantly under the influence of the stressors that perpetuate various nonspecific responses on the body. If the body is in this constant state of stress, then it will remain in perpetual biological response to that stress. The body will thereby experience the inhibition of various biological functions, including a hindering of the digestive system, the immune system, and the overall biosynthetic machinery.

One of the main chronic stress hormones is cortisol. Cortisol is a glucocorticoid that is synthesized from the adrenal cortex under the influence of the hypothalamus and the pituitary gland. Under normal acute stress conditions, there is an efficient negative feedback mechanism that helps shut down the continuous secretion of cortisol when a certain concentration of the hormone is reached. It should be noted that cortisol synthesis and secretion follows a circadian rhythm, with its normal levels highest in the early morning hours and its lowest normal levels at around bedtime. Thus, although its secretion is not bad for the body, continuous high levels that do not respond to the normal feedback control mechanism of the body are damaging.

Cortisol is a gluconeogenic hormone, i.e., it helps in the production of glucose. In fact, it does so at the expense of almost every other molecule in the body. For instance, when the body's reserves of glucose and glycogen are exhausted, cortisol stimulates protein degradation and lipid breakdown to provide amino acids and fatty acids, respectively. Those amino acids and fatty acids are then taken along a gluconeogenic pathway to be converted into glucose for use by the body. It is this process that actually creates the inhibitory effect on all biosynthetic pathways. Thus, amino acids are used for energy rather than for making vital proteins such as enzymes, hormones, receptors, antibodies, cytokines, and various other biomolecules.

As the digestive system is inhibited and absorption of nutrients is further impaired, there is an increased need for glucose. Usually, persons under chronic stress tend to eat more sweets precisely because a chronic stress lifestyle creates those sugar cravings. This situation is complicated by the insulin inefficiency created by the excess cortisol. Ultimately, there will be a risk for diabetes and for the formation of glycated end products in the body. Glycation is a biochemical reaction resulting in the binding of glucose molecules to proteins. It constitutes a major problem, as it voids the functionality of the glycated proteins. For instance, the glycation of hemoglobin prevents its oxygen transport function and leads to the death of tissues, as they are deprived of oxygen.

Under chronic stress conditions or in some pathological cases such as the Cushing's disease, excess cortisol is continuously poured into the body. Unfortunately, this leads to further activation and stimulation of catabolic reactions that break down muscles, bones, connective tissues, and lipids in order to provide more glucose to the body. This is in addition to inhibiting the digestive system, immune system, and reproductive system described earlier, which hinders proper growth and development. As the stress biological responses set in, there is further lowering of the basal metabolic rate. This low metabolic rate combined with increased sugar consumption will often lead to fat accumulation in certain parts of the body, as seen in patients with Cushing syndrome.

In relation to the nutrient acquisition process, excess cortisol that is not properly regulated in the system leads to the following:

- Decreased appetite
- Reduced saliva production
- Increased gastric acid production
- Reduced protective gastric mucous production
- Reduced synthesis of pancreatic enzymes
- Reduced blood supply to the GI tract
- Reduced absorption of nutrients
- Inhibited GI contractions and peristalsis
- Reduced insulin action
- Overall reduced biosynthetic reactions

The overall consequence of chronic stress conditions is that it places a further burden on the digestive system. This can lead to ulcer formation, improper digestion, poor absorption, excess acid production in the stomach, reduced peristalsis, increased fermentation / putrefaction mediated by the various intestinal microorganisms, constipation, and other digestive disorders. The longer the body maintains itself under a chronic stress lifestyle, the more degenerated and impacted the digestive system will be.

As a result of these metabolic disorders caused by excess cortisol in the system, there is a higher risk for the onset of many diseases. For instance, when the effect of inadequate gastric mucous production to protect the lining of the stomach is combined with the increased gastric acid production, there is high risk for ulcer formation. Additionally, the unprotective nature of the gastric lining will render the terrain more favorable for *Helicobacter pylori* infection. Poor peristaltic movement along the GI tract creates conditions that may promote diverticulosis, excessive fermentation, production of toxic bacterial metabolites, inflammatory bowel diseases, gastro-esophageal reflux disease, constipation, diarrhea, flatulence, and other conditions.

In addition to the cortisol effect on the digestive system, the sympathetic nervous system also acts by inhibiting most of the digestive functions. In fact, it can be concluded that the parasympathetic nervous system is associated with digestive function and stimulation, whereas the sympathetic system that is fired under stress conditions is associated with digestive inactivity and inhibition. For instance, any time one eats under stress, there is very little benefit to the cells in terms of proper nutrient acquisition. This happens when one eats while anxious, angry, rushed, or otherwise in a highly excited status. For instance, most people lose their appetite when they are told bad news just prior to eating. That is just one type of a very typical digestive system "shut down" that occurs when the body is overly stressed. The expression "I have a knot in my stomach" illustrates the stress effect on the GI tract.

Although acute stress cannot be prevented in daily life events, it is important both to control chronic stressful situations and to abstain from continuous worries and the constant unrealistic exaggeration of events. Additionally, it is important to eat under relaxed conditions, thereby allowing the parasympathetic nervous system to fully adjust and stimulate the digestive functions necessary to bring all the needed nutrients to the cells in the body for vitality, health, and longevity.

Good nutrient acquisition under relaxed conditions makes the body look younger and stronger, whereas there is a breakdown of bone tissue, connective tissue, and muscles when under chronic stress. This results in weak muscle tone, an inability to build muscles, susceptibility to osteoporosis, and wrinkled, scaly skin with low elasticity.

As stated earlier, the immune system is also weakened during conditions of chronic stress. This together with the poor biosynthetic processes in the body results in the following:

- Poor healing process after infections
- Injuries that tend to linger for a long time
- Increased risk for cancer
- Increased DNA mutations
- Overall susceptibility to opportunistic diseases

In conclusion, nutrient acquisition is of paramount importance to the cells of the body in order for them to perform their life functions. Chronic stress impairs this vital process and sets the terrain for poor health and increased susceptibility to disease. The longer the body has been subjected to chronic stress and its induced hormones, the higher the risks for an impaired digestive system. Individual forms of stress management may vary from person to person, but their goal should be to minimize chronic stress through adopting good relaxation methods that help control excess cortisol and sympathetic nervous system stimulation. Equally important is the use of dietary enzyme and probiotic supplementation to assist the digestive system impaired by constantly living under stress conditions.