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Dietary Fasting as a Treatment for Type 2 Diabetes

Dietary changes such as fasting shows promising results as being the key to improving insulin sensitivity and optimizing insulin utilization in those with type 2 diabetes by combating obesity and promoting a healthy lifestyle. There is a societal stigma surrounding the concepts and effectiveness of fasting in everyday life. Many view fasting as depriving the body of essential macro and micronutrients for an extended period of time. This is simply not the case, many unjustifiably group fasting and starvation together. Starvation is defined as the involuntary abstention from eating. Unlike starvation, fasting is the voluntary abstention from eating. Reasons for this can vary, including spiritual commitment, weight loss, or other personal reasons. (Fung and Moore). The notable difference between starvation and fasting is that food is readily available for consumption, however a conscious choice is made not to eat. There is an array of fasting techniques and practices, in fact, considering that fasting is by definition the absence of eating, anytime the body is not consuming food it is technically in a fasting state. Subconsciously, humans fast daily, every night when we get into bed, the body enters a fasted state. Extending that already present fast so that it aligns with more advanced fasting protocols could, in fact, improve insulin sensitivity and optimize insulin utilization in those with type 2 diabetes.

History of Fasting

Fasting has been a common practice across many cultures and has been practiced longer than any other dietary technique. The question becomes: why is fasting not a widely practiced dietary technique today? As a society we have been taught to prioritize eating to ensure that we consume regular wholesome meals. In fact, health officials allude to the alleged dangers and complications that can arise from skipping just one meal. We have been taught to constantly eat with phrases such as "breakfast is the most important meal of the day," and "you must never miss a meal." As time went on, we continued to value the idea that it was dire to our survival as humans that we eat three square meals a day. This begs the question: is hunger even the driving factor of eating anymore or are we just eating because that is what we are supposed to do? This type of thinking is what has caused a multitude of problems associated with overeating and consumption of unnatural processed foods for convenience. The line between a healthy natural balance of feeding and fasting has ultimately been blurred and become obsolete. Instead of balanced periods of eating and fasting, human beings are consuming food for as long as sixteen to eighteen hours a day with only six hours of fasting (Paoli et al.).

Food consumption: Insulin & Glucose

What happens when we eat? There is one key hormone that is involved in virtually every aspect of food consumption and energy expenditure. That hormone is insulin. Insulin is responsible for the storage and use of food energy. When we consume food, insulin increases. Carbohydrates, proteins, and fats, all stimulate insulin production. Carbohydrates and proteins more than fats but none the less the three main macronutrients cause insulin levels to rise. Therefore, we consume food, insulin levels rise, sugar is stored, and fat is produced in the liver. But what if we could use insulin fluctuation to our advantage? Well, we have been, while insulin

does increase stored sugar and fat production in the liver, it is a vital component to our biology and is critical in maintaining a homeostatic state.

Insulin has two major functions in the human body. First, insulin allows the body to immediately start using food for energy. Carbohydrates are absorbed and rapidly turned to glucose, raising blood sugar levels. Insulin allows glucose to enter directly into most cells of the body, which use it for energy. Proteins are broken down into amino acids and absorbed, while excess amino acids are converted into glucose. While protein does not raise blood glucose, it can raise insulin levels. Surprisingly, protein can stimulate insulin as much as carbohydrate-containing foods, while fats have little effect on insulin because they are absorbed as fat and not glucose. Second, insulin helps store excess energy. Since we consume such large amounts of foods the body has been able to adapt to store large amounts of energy within our body for later expenditure. Glucose molecules can be linked into long chains called glycogen and then stored in the liver. Humans have become incredibly efficient in using and storing glucose so that we may give our bodies the best possible chance of survival. Unfortunately, there is a limit to the amount of glucose that can be stored in the body. Once this limit is reached, the body starts to turn glucose into fat in a process that is called *de novo lipogenesis*, which means, "making fat from new" (Fung and Moore). The fact of the matter is our body wants to put us in the best possible position to survive and ultimately thrive. Therefore, the body has found a new way to store this vital glucose that is essential to our survival. Unfortunately, this process puts us at much greater risk to metabolic deficits. The newly created fat from excess glucose is stored as fat in the liver or in fat deposits in the body and has no limits. The body will continuously convert excess glucose into fat and store it for as long as it is needed. There is no limit, this essential process may in fact lead to our demise as humans.

Luckily for us, recent research alludes to an answer and that answer is fasting. When we fast the process of using and storing food energy is reversed. When humans fast, we cut off the constant influx of new glucose into the body and we are forced to rely on what is stored. If our body was not effective in storing glucose, fasting, without a doubt would kill us. Since this is not the case, the fasted state of our body forces us to revert stored glucose and fat back into energy to keep us alive. When we fast, insulin levels drop, signaling the body to start burning stored energy. Glycogen is first, it is the most easily accessible energy source, and thankfully the liver stores enough glycogen to keep us alive for roughly twenty-four hours (Fung and Moore). When that store runs out the body will start to break down stored body fat for energy.

This system is in a constant state of firing or rest. Similar to fight or flight your body is either storing or using glucose for energy. The body only exists in two very distinct states, the fed high-insulin state, and the fasted low-insulin state. Hence, if we are fed more than fasted, we will experience weight gain, and if we are fasted more than fed, we will lose weight. It is an interchangeable equation that at its source determines how much weight we gain or lose. We have been unintentionally doing this since the very beginning of time and this is nothing new. The distinction is, we are intentionally doing it. This is strategic, there are no adverse health consequences to activating these evolutionary protocols.

Since ultimately all food consumption results in an increase in insulin, the absence of food will without fail, decrease insulin levels. Regularly lowering insulin levels lead to improved insulin sensitivity, meaning your body is much more responsive to insulin. Considering that insulin resistance is the root problem of type 2 diabetes lowering insulin levels in a strategic manner becomes necessary, in those who are prediabetic or at risk for developing diabetes.

Type-2 Diabetes

Type 2 diabetes is a chronic condition that has detrimental effects on the way one's body metabolizes glucose ("Type 2 Diabetes - Symptoms and Causes"). Considering the previous data and information regarding the implications of being unable to metabolize glucose, understanding diabetes becomes equally as important. Specifically, type 2 diabetes is caused by the body's resistance to insulin. Ample data suggests that genetics, environmental factors, obesity, and a sedentary lifestyle could be to blame. In type 2 diabetes the mechanisms discussed before are virtually inactive. Type 2 diabetes makes the different processes involved in insulin production and glucose utilization incredibly inefficient. In type 2 diabetes the cells do not respond normally to insulin, rendering the cells insulin resistant. Therefore, instead of glucose moving into the cells, it builds up in your blood stream. This results in an increase in blood sugar levels as well as stimulation of beta cells in the pancreas to release more insulin. This eventually causes mutation in the cells and impairs its ability to make enough insulin to meet the body's needs. The pancreas becomes unable to keep up with the demands for insulin resulting in type 2 diabetes. Unlike many other health conditions, type 2 diabetes is often caused by an individual's lifestyle choices. Likewise, it can be treated and managed by an individual's lifestyle choices. If treated properly and timely an individual can manage their diabetes with healthy eating habits and a proper physical activity regiment. In addition, a common treatment for type 2 diabetes is insulin supplementation or other injectable or oral medicines to manage blood sugar levels and avoid complications (CDC).

It is imperative that the individual closely monitors blood sugar levels and takes necessary steps to ensure blood sugar levels stay within a target range. While insulin shots and close monitoring of blood sugar levels are extremely important in the treatment of type 2

diabetes it is in no way a cure. As is the case with many other diseases, medical professionals work tirelessly to find a cure in hopes of changing millions of lives. Unfortunately, as of right now, they have been unsuccessful. While proper management has provided many with the ability to live with type 2 diabetes, medicine has been unable to find a cure. What I am suggesting is we look at the problem as the solution. We prioritize the importance of diet and meal frequency to hopefully improve insulin sensitivity and make injectable medication a thing of the past. Afterall, there is a clear association between type 2 diabetes and obesity, and weight loss often reverses this type of diabetes.

Unlike type 2 diabetes, in type 1 diabetes, individuals lack insulin, making insulin injections a life-saving treatment. However, there is not much success with insulin injections for people with type 2 diabetes because they are not lacking insulin. In fact, they are making too much which causes the insensitivity. Considering that insulin's main job is to move glucose from the blood into the tissues, when presented with a cell already packed with excess glucose it does not allow insulin to properly do its job resulting in an unusually frequent high blood sugar. The body combats this by producing excess insulin to force the glucose out of the blood and into the tissue. However, the cells have no room for new glucose thus excess insulin is unable to do its job and simply results in this process becoming ineffective. Medication offers a quick fix; diabetes medication often works to increase insulin production so that the cell has no choice but to accept new glucose. This may work at first and could possibly last years, but this does not address the underlying issues of excessive insulin production and excess glucose. The next key step is decreasing the excess glucose in cells, which would result in less insulin being needed to perform these functions. A decrease in excess glucose in cells will allow more room for new glucose to enter cells via insulin. Since there is more room for glucose, there is no need for

excessive insulin, a normal amount is plenty to get the job done. Fixing the underlying problem of excess glucose in a cell will have a waterfall effect improving health substantially. Less glucose in the cells allow new glucose to be cycled into cells for energy.

Fasting's effects on the body

Fasting offers a viable solution to decreasing stored glucose which ultimately decreases excess insulin and improves insulin sensitivity. Fasting does this in two ways. First, it cuts off new glucose from entering into the body. If no new glucose comes in, blood sugar will decrease and build up will stop. Second, fasting allows the body to burn off excess glucose in order to supply your vital organs with energy. The initial cut off of new glucose will force the body to use its stored glucose thus freeing up more room for glucose to be moved into cells from the blood via insulin and ultimately improving the body's response to normal levels of insulin and begin to reverse the effects of insulin insensitivity. Once blood sugar levels are in consistent ranges, you are no longer considered diabetic.

Overall, there are many key steps that happen when we begin a fast. George Cahill, a contributor to Dr. Jason Fung's book, and leading expert in fasting physiology, states that the transition from the fed state to the fasted state occurs in several critical stages. First, is feeding phase. Blood sugar levels rise as we absorb incoming food, and insulin levels rise in response to more glucose in cells which use it for energy. Excess glucose is then stored as glycogen in the liver or converted to fat. Second, is the postabsorptive phase. This phase last roughly six to twenty-four hours after beginning the fast. Blood sugar and insulin levels begin to fall. To supply energy, the liver starts to break down glycogen, releasing glucose, this lasts from approximately twenty-four to thirty-six hours. Third, is gluconeogenesis. This phase begins approximately twenty-four hours into the fast and lasts to the forty-eight-hour mark. Glycogen stores have run

out at this point and the liver manufactures new glucose from amino acids in a process called *gluconeogenesis*. Glucose levels fall but stay within normal range. Next, ketosis occurs. This usually occurs two to three days after beginning a fast. Low insulin levels stimulate lipolysis, which is the breakdown of fat for energy. Lastly, the protein conservation phase begins five days after fasting. High levels of growth hormones maintain muscle mass and lean tissue while energy is almost entirely supplied by fatty acids and ketones. Increased norepinephrine prevents decrease in metabolic rate. Ultimately this process tells the body to use stored fat for energy and not glucose (Fung and Moore).

How to Fast

There is an array of fasting techniques that result in the desired outcomes aforementioned. Distinguishing between types of fasts can be categorized by two distinct features: what is allowed on the fast and how long or frequent the fast is. The majority of fasting techniques allow noncaloric drinks only during a period of fasting. Noncaloric drinks include things such as water, tea, and black coffee. It is imperative that individuals who begin a fast avoid sugar, fructose, and other sugars. Some, more strict fasts, include water only fasting stages where you are only consuming water while fasted. Frequency and duration of a fast is just as important as what is allowed during a fast. When it comes to fasting, timing is everything. There are two very distinct types of fasting based on duration and they can be classified as intermittent fasting and extended fasting. During longer fasts, health benefits—including weight loss and reduced insulin levels—accrue quickly, but there is also a higher risk of complications for diabetics and those who are taking medications. This is an important distinction when it comes to adherence in protocols of fasting. More times than not, individuals will be quick to jump at an opportunity that promises quick and effective results. However, an extended fast requires

immense discipline and commitment which is often not practical for the average person. During longer periods of fasting, it is imperative that an individual speaks with their doctor and has the means to be monitored by a doctor. Longer fasts include protocols such as 24-hour fasts and 36-hour fasts. While these are extremely effective in drastically reducing insulin levels in a short amount of time, research suggests that a more systematic, long-term solution may offer more benefits for the individual in the long run.

Considering that the goal of a dietary protocol such as fasting is to lower our insulin response to food, timing and frequency of meals becomes the most important factor. The question of *when* to eat is as important as *what* to eat. This is precisely where intermittent fasting may help us the most. At its most basic definition intermittent fasting can be simply classified as periods of fasting that occur regularly between periods of normal eating. Sounds simple enough, right? This also allows for variety among individual protocols that offer the best fit. Intermittent fasting affords individuals the opportunity to fit fasts into work and family-life schedules easily while also minimizing the risks of malnutrition (Mattson et al.). In order to have a successful fast one needs to prioritize meal frequency and timing. Lower frequency but with regular timing drastically reduces the risk of weight gain (Paoli et al.). Intermittent fasting regiments include options such as a 12-hour fast, a 16-hour fast, and a 20-hour fast. While 12-hour fasts offer a great preventative strategy, it is simply not powerful enough to reverse weight gain and ultimately lower insulin levels. The daily 16-hour fast offers a more powerful response than the daily 12-hour fast and should be accompanied with a low-carbohydrate diet for the best outcomes. A daily alternate-day fast also shows promising outcomes. Weight loss tends to be slow, however, it affords an individual to consistently lose weight with a relatively low stress on body and hunger patterns.

Meal Frequency

One key aspect of fasting and food consumption is our internal circadian clock. Hunger follows a natural circadian rhythm that is independent of the eat/fast cycle. Ghrelin, the hunger hormone, rises and falls in a natural circadian rhythm. These are natural rhythms inherent in our genetic makeup. Hunger is not so simple as "the longer you don't eat, the hungrier you'll be." Hormone regulation of hunger plays a fundamental role (Fung and Moore). The body circadian timing system is composed by a central clock in the hypothalamic suprachiasmatic nucleus and by different peripheral tissue clocks. The circadian clock system involves many metabolic rhythms including glucose and lipids. Whilst the body's central clock dictates food intake, energy expenditure and insulin sensitivity, peripheral/tissues clock carry out an additional control. For instance, the peripheral clock in the gut regulates glucose absorption and peripheral clocks in the adipose tissue and liver regulate their insulin tissue sensitivity while another peripheral clock in the pancreas regulates insulin secretion (Paoli et al.). Nighttime eating has a direct correlation with obesity. For example, on average, obese individuals consumed most of their calories an hour closer to melatonin onset (biological marker of impending sleep onset) compared to lean individuals (McHill et al.). Circadian clocks influence insulin resistance through glucose absorption, muscle, fat, tissue, and liver insulin sensitivity and food intake or nutritional challenge influence, in turn, circadian clock (Paoli et al.). Much research in recent years suggests a positive effect of a wide temporal fasting window during the day, i.e., limiting daily food intake to a ~6-8 hour time window seems to induce, in humans, many health benefits compared to the normal daily meal distribution (i.e., three to five meals, spread from breakfast to late dinner), even in isocaloric conditions (Rothschild et al.). Effects of different meals timing and frequency has drastic effects on different variables. Two meals a day, which include a

healthy breakfast and eating patterns that conclude at 15:00-16:00 hours have proven to increase insulin sensitivity, decrease hunger, and decrease inflammation (Paoli et al.). These outcomes are very similar to the desired goals of improving insulin sensitivity in individuals with type 2 diabetes as well as reducing obesity. It is no coincidence that intermittent fasting follows very similar protocols.

Outcomes

The goal of intermittent fasting in this case is to lower body fat while depleting stores of glucose and freeing up glucose in the blood. By doing this, it allows for normal levels of insulin to be adequate in moving glucose from the blood to the tissue without the need of excess insulin which causes the insensitivity of the cells. Intermittent fasting interventions induce a metabolic shift that has the potential to positively alter body composition. This switch represents a shift from preferential lipid synthesis and fat storage to the mobilization of fat. This typically occurs when glycogen in the hepatocytes becomes depleted. Around that time, accelerated lipolysis in adipose tissue produces increased plasms levels of FFAs, which contribute to the increased synthesis of fatty acid-derived ketones in the liver, kidney, astrocytes, and enterocytes. These intermittent fasting regiments show incredible potential in treatment of obesity and other diabetic risk factors while also showing reliable results in treatment of type 2 diabetes (Zubrzycki et al.). Compared to low-calorie diets, intermittent fasting regimens promote greater reduction of fat mass and possibly smaller post-intervention weight regain (Zubrzycki et al.). In addition, a recent trial with men that are overweight or obese with prediabetes showed that early time-restricted feeding, i.e., intermittent fasting, for five weeks, significantly reduced fasting insulin concentration and improved the OGIT-derived indices of beta cell responsiveness and insulin resistance, even without weight loss (Zubrzycki et al.). This shows that not only is fasting

appropriate as a diabetic intervention strategy but is also appropriate as a pre-diabetic intervention strategy.

A case study out of the Intensive Dietary Management clinic in Toronto, Canada showed promising results of intermittent fasting as an alternative to insulin. The case series documents three patients who are insulin-dependent type 2 diabetics. All three cases exemplify that therapeutic fasting may reduce insulin requirements in type 2 diabetes. It is understood that lifestyle modifications are universally acknowledged to be the first line of treatment in type 2 diabetes, however, glycemic control is difficult to achieve in majority of obese patients. All patients followed similar dietary regimens. Patients 1 and 3 followed alternating-day 24-hour fasts and patient 2 followed the triweekly 24-hour fasts schedule. At each visit, patients' daily blood sugar diaries were reviewed for further dietary and medication adjustments made if needed. Blood sugars were measured by patients at least four times a day during the insulin-weaning period. Target daily blood sugars were <10 during the initial insulin-weaning phase and <7 thereafter. In addition, patients' weight, waist circumference and blood pressures were measured and recorded at each visit (Furmli et al.). The case study had five outcomes that they measured: time to discontinuation of insulin, fasting blood glucose, serum A1C level (%, mmol/mol), patient weight (kg), and patient waist circumference (cm). The most noteworthy outcome from this case series is the complete discontinuation of insulin in all three patients. In addition, there was a general reduction of hemoglobin A1C (HbA1C) levels for all patients' during the course of the fast. As well as no symptomatic episodes of hypoglycemia were reported in any of the patients. This widely successful case study shows that the implications of fasting techniques show promising results in the discontinuation of insulin via lowering blood sugar levels and increasing insulin sensitivity. It is worth noting that all three patients in the study

report the fasting protocol to be well tolerated and no patient stopped fasting at any point during the experiment. In general, the feedback received from the patients' was very positive and many commented on enjoying being actively involved in the process of managing their diabetes (Furmli et al.).

Adherence to instruction was crucial in this case study. Often times adherence is compromised due to many common misconceptions of fasting. It is important to distinguish between feeling hungry and feeling sick. It is recommended that if a patient feels sick it is imperative that they discontinue their fasting regiment and discuss with their doctors. It is important to understand that fasting is responsible for an extensive list of health benefits. While fasting, insulin inevitably decreases, and electrolytes remain stable. In addition, adrenaline, metabolism function, and growth hormone all increase. Decreased insulin levels is one of the most consistent hormonal effects of fasting.

Common Misconceptions

A common fear of fasting is electrolyte imbalances. Prolonged studies of fasting have found no evidence of electrolyte imbalances—the body has mechanisms in place to keep electrolytes stable during fasting. In addition, adrenaline increases and metabolism speeds up. Many assume that you will feel fatigued when in reality fasting can have the opposite effect. The body is still receiving nutrients, the difference is your body is getting energy from burning fat rather than burning food. Growth hormone also increases exponentially. Growth hormone increases the availability of fats for fuel by raising levels of key enzymes, such as lipoprotein lipase and hepatic lipase. Burning fat reduces the need for glucose, this maintains stable blood sugar levels (Fung and Moore). Evidence supports that not fasting actually has a direct effect on

suppressing growth hormone levels by as much as 80 percent. The most natural stimulus to growth hormone secretion is fasting (Fung and Moore).

Accompanied with fasting, the basics of good nutrition can be summarized by eating whole, unprocessed foods. Avoiding sugar, and refined grains is imperative. Eating a diet high in natural fats while balancing feeding with fasting is the perfect storm. One may say this sounds a little too good to be true, there has to be side effects of fasting. Thankfully there are no side effects, of course extended fasting presents a risk for medical complications, in addition it is not recommended to fast as a child or when pregnant and breast feeding. To the average person, fasting is virtually side effect free. Fasting will decrease glucose, blood pressure and in fact may lower your risk of cancer. In addition, increased growth hormone has unfathomable health benefits. Increasing growth hormone naturally allows the body to reap all possible benefits of this powerful hormone without the extensive list of side effects that result from artificial growth hormone (Fung and Moore).

Conclusion

The field of medicine changes each and every day. Every new patient and every set of symptoms is unique. Treating type 2 diabetes with lifestyle modifications, injectable and oral medication, and sometimes surgery is treating the disease as a whole and not the symptoms. The overall goals of caring for patients with type 2 diabetes is to reduce the symptoms and to prevent or slow the development of complications. Therapeutic fasting is a viable solution to improving the underlying deficits that are presented with type 2 diabetes. Therapeutic fasting has great potential to lower blood sugar, improve insulin sensitivity, and ultimately afford patients' the opportunity to discontinue all medication. The Intensive Dietary Management clinic in Toronto, Canada proved that this an area worth exploring. While therapeutic fasting is a new and

developing field of treatment it is a promising one. Before 2018 there was virtually no documented or published studies or cases with respect to therapeutic fasting as a cure for type 2 diabetes, reversing it completely and eliminating the use of insulin. Educating patients' and further research into the benefits of fasting in the management of type 2 diabetes may aid in the remission of the disease and curtail the use of pharmacological interventions. Proper education on an appropriate treatment plan tailored to the individual is imperative to the success of the individual. Likewise, adherence to a fasting diet should be stressed throughout treatment of type 2 diabetes, because these key lifestyle measures and modifications can have a large impact on the degree of diabetic control that patients can achieve. In a world where battles are fought over medicine and resources, a simple technique of dieting becomes extremely hard to ignore.

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