The Biochemical Effects of Biomagnetic Therapy on Type II Diabetic Rats

and potential use in Nanotechnology

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Abstract— this study was done to determine the effects of biomagnetic therapy on non-fasting blood glucose levels in type II diabetic (TIID) rats and to identify the potential use of biomagnets in nanotechnology for treating diabetes. For a gender unbiased research, both male and female streptozotocin induced TIID Sprague-Dawley rats (16 each) weighing 150-250g were assessed, with and without biomagnetic therapy using 5000 gauss magnetic bracelets. Non-fasting blood glucose levels were measured in the blood collected from their tail, once weekly for sixteen (16) weeks using a portable glucometer (Glucolab Blood Glucose Monitoring System). Results showed that there was a significant ($p<0.05$) and consistent reduction of non-fasting blood glucose levels (NFBG) over the experimental period for diabetic groups that were under the influence of biomagnetic with average blood glucose levels for the final month being 8.35±1.06 mmol/L as compared to the non-treated diabetic rats (control) which averaged blood glucose levels of 31.39 ± 3.94 mmol/L. Results were compared to known goal blood glucose levels for diabetics. Biomagnetic therapy can facilitate the management of type II diabetes by lowering non-fasting blood glucose levels as groups exposed to the biomagnetic therapy showed blood glucose levels trending to that of normo- glycaemic levels of 4.0-7.7 mmol/L. There is great potential for the use of biomagnets in nanotechnology, particularly in the treatment of diabetes, such as targeted site treatment for inflammation associated with TIID, or drug delivery systems.

***Index Terms*— Biomagnetic Therapy, Type II Diabetes, Sprague-Dawley Rats, Non-Fasting Blood Glucose, Nanotechnology**

I. INTRODUCTION

A. Biomagnetic Therapy and Diabetes

All over the world persons are wearing biomagnetic jewelry in hopes that it will help to cure and maintain chronic illnesses such as diabetes with over 347 million people worldwide suffering from this disease [22]. Diabetes is metabolic diseases which are generally categorized by hyperglycemia caused by defects in insulin secretion as well as its action. Prolonged hyperglycemia can cause lasting dysfunction, damages and failure of organs such as the liver, kidneys, pancreas nerves and blood vessels [8][9]. Even though so much is already known scientifically about both types of diabetes, namely, type 1, defined as an autoimmune disease destroying or damaging the beta-cells in the islets of Langerhans resulting in insulin deficiency and hyperglycemia; and type II, which is characterized by high blood glucose due to insulin resistance and qualified insulin deficiency; there is still a great demand for more knowledge as individuals, both diabetic and non-diabetic seek an alternative way to control and/or prevent this disease without the use of drugs [9]. One such alternative has always been based on a diet but more recently, focus has been placed on unconventional energy therapies such as the ancient art of biomagnetic therapy.

The biomagnetic industry boasts to be a multi-million dollar industry today and is steadily increasing in value, and the thought that a one-time investment can lead to a lifetime of benefits, makes biomagnetic therapy an attractive and cost effective treatment for diabetes, making it even more important to find out the biochemistry behind how effective it truly is as this is yet to be documented. The concept behind biomagnetic therapy is mostly based on the fact that some cells and tissues in the human body give off electromagnetic impulses and the magnetic field produce by the magnetic interferes with these impulses, however studies have shown that this has no impact on the body [21]. Common thoughts are that magnetic fields attracts the charged particulates in the body and can increase the blood flow, increase the flow of oxygen to cells, decrease fatty deposits on artery walls, alter nerve impulses, and even increase alkalinity of bodily fluids and moves ions. It is claimed that if the diameter of the body's blood vessels increases then more blood is allowed to flow through which carries nutrients and oxygen to the injured area and as the blood flows back it leaves with the tissue's toxins, although no significant evidence suggests these claims [12]. According to research carried out by Pittler et al in 2007, no evidence supports the use of static magnets for pain relief,

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and furthermore the study concludes that magnets, as an effective treatment, cannot be recommended. However, it also stated that for osteoarthritis, there was insufficient evidence to rule out possible clinical benefits, creating an opportunity for further [17].

It is often believed that because the oxygen in our blood is carried by hemoglobin and that hemoglobin contains iron then there should some degree of interference, but this can be disregarded factually as the iron in hemoglobin is not ferromagnetic, meaning is not attracted to magnets, and thus does not affect blood flow [4]. However, Dr. Null, author of the book "Healing with Magnets" thinks otherwise as he states that a positive charge is emitted by injured tissue; thus by placing a negative pole of a magnet over the area it will be able to restore a natural balance as it improves circulation allowing blood vessels to dilate bringing more blood to the injured area [15]. He further states that this helps in removing toxic by-products inflammation may cause such as bradykinens, histamines and prostaglandins thus, pain and inflammation are reduced, stimulating tissue healing [15]. These claims however, were not supported by any scientific findings in this book. The topic of biomagnetic therapy is a very controversial topic, and despite the many claims it has no significance without scientific evidence. Research done suggests that inflammation participates in the pathogenesis of type II diabetes [2]. If biomagnetic therapy does have its claimed anti-inflammatory effect then it can aid in the prevention of type II diabetes. Long-term complications for an individual with a consistent high blood sugar level can be endless from strokes, diabetic retinopathy affecting the eye sight, heart disease, kidney failure to even amputations due to poor circulation [3]. For this reason it is important to fully understand how type II diabetes affects each of the major organs that are most greatly affected in the body, namely the liver, kidney, intestine and pancreas and the possible effect low glycemic index diet and magnetic therapy may have on the disease's condition on biochemical and morphological parameters [24] [2].

B. Nanotechnology and Diabetes

Nanotechnology can be defined as the science and engineering involved in the design, synthesis, characterization, and application of materials and devices whose smallest functional organization in at least one dimension is on the nanometer scale or one billionth of a meter [20]. Over the years nanotechnology has blossomed and multiple applications are now being actively investigated. Potential use in diabetes includes non-invasive glucose monitoring using implanted nanosensors, fluorescence resonance energy transfer (FRET) and fluorescence lifetime sensing, and the newly developed nano-encapsulation technologies for sensors such as layer-by-layer (LBL) films [17]. Uncovering the biochemical effects of biomagnetic therapy in TIID can aid in developing new nanomedicines such as targeted site treatment for inflammation, or unique drug delivery systems.

Over the years the number of type II diabetics is raising, not only in the Caribbean but the world. Most alarmingly, the rise is not only in older individuals, as would be expected, but in the younger generation with 11.8 percent of a 25.6 million population sample with this disease [13]. The topic about possible positive effects of biomagnetic therapy not only on diabetics but for any general medical disorder is one that brings about many sceptics and from the scientific knowledge now currently present this criticism cannot be excused. It is already known that nanotechnology employs various magnetic properties. A study done shows an innovative drug delivery system based on magnetic and fluorescent multifunctional chitosan nanoparticles, combining what is termed magnetic targeting and fluorescent imaging to create stimulus-responsive drug release properties into one drug delivery system [11].

By investigating the biochemical effects of biomagnetic therapy on type II diabetics some of the speculations and uncertainty as well as debate can be put to rest surrounding biomagnetic therapy as well its potential use in nanotechnology.

II. METHODS

Sprague-Dawley rats weighing 150-250g at 90 days of age were obtained from the Animal House of the University of the West Indies. Animals were housed in stainless steel cages, which were cleaned daily and under a 12/12-hour light/dark cycles with rats having free access to food and water. A modified version of previously used protocol for Fructose-fed streptozotocin-injected rat model for type 2 diabetes; Wilson et al, 2012 was used to induce type II diabetes in rats. Male and female Sprague-Dawley rats (150 – 250 kg) were fed with rat pellets and 10 % fructose solution in place of water for the initial 2 weeks after which rats were intravenously administered 40 mg/kg BW streptozotocin (STZ) of concentration 15 mg/ml in a citrate buffer of pH 4.4. Rats were fed normal drinking water for reminding of experiment. Animals with non-fasting blood glucose (NFBG) level > 16 mmol/L one (1) week after STZ injection were considered as diabetic. Magnetic bracelets of 5000 gauss in strength were purchased from Billy the Tree, FL, U.S.A [1], and worn on specific rat groups around the neck region for a period of three (3) months. A total of 4 groups of 8 rats each (4 males and 4 females) were used. For identification purposes, each rat was assigned a colour code. Rats were fed once daily with Formulab Diet rat food purchased from OK Feed Store, Miami, FL., U.S.A and water. 2 hour postpordinal blood glucose levels were measured in the blood collected from tail, once weekly for twelve (12) weeks using a portable glucometer (Glucolab Blood Glucose Monitoring System). Animals were sacrificed after experimental period using Sodium Pentobarbital 100 or > mg/kg IV as euthanasia agent and blood and organ samples collected for further biochemical, physiological and morphological testing. Animals were maintained in accordance to the rules and regulations of the University of the West Indies, Mona Animal Ethics Committee (Ethical approval number: AN 17,13/14).

III. RESULTS

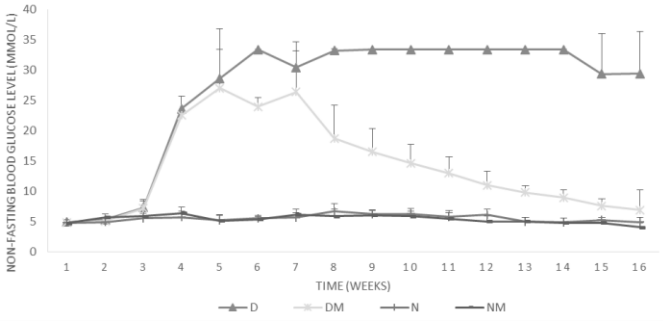

Fig. 1. Mean Non-Fasting Blood Glucose (mmol/L) Over 16 Weeks of Rats treated with Biomagnetic Therapy (DM: Diabetic+Biomagnet; D: Diabetic only; NM: Non-Diabetic + Biomagnet; N: Non-Diabetic only). Data are shown as the mean ± SD of 24 animals; $p < 0.05$ *One Way ANOVA* test.

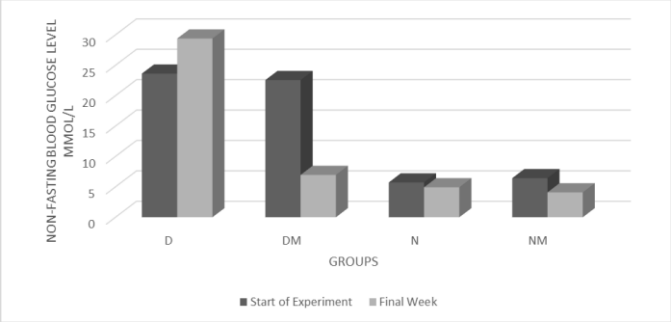

Fig. 2. Mean Non-Fasting Blood Glucose (mmol/L) Over 16 Weeks of Rats at Beginning and Ending of Experiment (DM: Diabetic+Biomagnet; D: Diabetic only; N: Non-Diabetic only; NM: Non-Diabetic + Biomagnet). Data are shown as the mean ± SD of 24 animals; $p < 0.05$ *One Way ANOVA* test.

IV. DISCUSSION

There was a significant decrease in non-fasting blood glucose levels for the diabetic rats with biomagnets when compared to the untreated diabetic rats which had blood glucose levels > 25 mmol/L for the 12 weeks of experimentation as seen in Fig. 1. Biomagnetic therapy can facilitate the maintenance and management of type II diabetes by lowering non-fasting blood glucose levels as groups exposed to the biomagnetic therapy showed blood glucose levels trending to that of normo- glycaemic levels of 4.0-7.7 mmol/L. It can clearly be seen from fig. 1 that the induction of type II diabetes was successful as rats averaged a non-fasting blood glucose level of >25 mmol/L at week 4. Untreated diabetic rats (group D) had the highest non-fasting blood glucose levels over the experimental period as expected. Untreated TIID can lead to several complications, such as damage to vital organs and even ketoacidosis. It was seen that from 7- 14 diabetic, untreated rats had very high NFBG levels of >33 mmol/L, however from week 15-16 the NFBG levels started to decrease. It can be assumed that this reduction of blood glucose levels in the final weeks was due to serious complications and a sign that rats were under a significant amount of stress and were possibly about to die due to the severity of the condition.

For the diabetic rats that was exposed to biomagnetic therapy (group DM) it was seen that their non-fasting blood glucose levels had an overall reduction with slight fluctuations in weeks 4-7. These fluctuations could be due to number of factors such as acclimatization of rats to the biomagnets. Based on the claims that magnetic fields attracts the charged particulates in the body and can increase the blood flow, increase the flow of oxygen to cells, decrease fatty deposits on artery walls, alter nerve impulses, and even increase alkalinity of bodily fluids and moves ions, made by Livingston, 1998; then it is feasible that there would be some level of fluctuations in blood glucose levels as the body adjusts to these changes, however, once acclimatized then the blood glucose level would be more controlled as seen in diabetic rats exposed to biomagnetic therapy after week 7. It was also claimed that the diameter of blood vessels increases with biomagnetic therapy. This would allow more blood to flow through carrying oxygen and essential nutrients to the injured tissues and in return leaves with the various toxins such as relative oxygen species, decreasing inflammation and aiding in cell restoration; however, there was no significant evidence for these claims [12]. The consistent reduction of the diabetic rats under magnetic therapy NFBG levels over the experimental period can indicate that there is a possibility that inflammation associated with organ damage from diabetes was reduced, helping to gain evidence that biomagnetic therapy can reduce tissue inflammation. Research previously done suggests that inflammation participates in the pathogenesis of type II diabetes [2][3]. Therefore, if inflammation is reduced by biomagnetic therapy then it can aid in the control and maintenance of diabetes by preventing further complications and preserving organ integrity.

It was also observed, as seen in Fig. 2 that the NFBG levels for non-diabetic rats with biomagnetic therapy had less fluctuations than that of the non-diabetic rats without the therapy. However, there were not any significant differences in NFBG levels over the experimental period as both were in speculated range for non-diabetic, non-fasting blood glucose levels of 4.0-7.7 mmol/L. These results would suggest that biomagnetic therapy can help to reduce slight fluctuations in NFBG levels in non-diabetics indicating that the body's sensitivity to insulin is maintained and thus reducing the future onset of TIID. From the above results, there is a high possibility that the theories surrounding the principles of biomagnetic therapy is true.

V. FUTURE WORK

Investigations on the biochemical, histological, morphological and physiological effects of biomagnetic therapy on TIID is now on going. In knowing these various interactions, potential use of biomagnets in nanotechnology for the treatment of diabetes can be researched *in vivo.*

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