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# Reversal of Hippocampus Atrophy in Advanced T2DM Patients under Restricted Glucose and Gluten-Free Diet and Exercise Regimen

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**Abstract**

This article describes a possible project in the fight against Type 2 Diabetes Mellitus (T2DM). Magnetic Resonance Imaging (MRI) machine may be used for structural brain scans periodically on advanced T2DM patients under a restrictive diet of glucose and no gluten and a regimen of daily aerobic exercises and brain exercises. The MRI scans will provide physical neural confirmation that there is reversal of atrophy in the hippocampus. This confirmation or otherwise will affirm the effectiveness or otherwise of the specific diet and exercise proposed.

**Keywords:** Sugar; Wheat; Barley; Rye; Brain; Alzheimer's disease

## Background and Motivation

Sugar and gluten have been implicated in T2DM [1]. Sugar has been implicated for a while now [2]. Intensive glucose lowering and cognition in T2DM have been studied [3]. The subregional hippocampal region was found by Apostolova et al., to have atrophied in dementia patients, and as a precursor to Alzheimer's Disease (AD) [4]. Researchers have done much work on the demented brain with MRI [4-7]. In ref. [5], "automated 3D mapping of hippocampal atrophy was performed on 400 subjects with AD." The resting-state brain functional connectivity was found to have altered in T2DM by Musen et al., [7].

## Gluten is a major risk factor in T2DM

The initial motivation of this proposal, which was mostly from nutrition and diabetes, came as a result of writing [1], "A perspective of one important risk factor of type 2 diabetes in Hispanic and Asian minorities", published in the Global Journal of Immunology and Allergic Diseases. Most of the references in the bibliography [8-32], were used in the writing of the refereed journal paper published online in June 2015. The important risk factor pointed out in the paper is gluten from wheat, rye and barley.

We can inform experimental medicine whether gluten is indeed a good item to cut from their diet, regardless of whether the person has celiac disease or shown gluten intolerance in any form. It is proposed to reduce patient's intake of sugar to less than 5% of calories consumed per day, as per World Health Organization's (WHO) recommendation [1].

The advantage of the use of the MRI compared to just the traditional glucose test and A1C is that additional information and confirmation is obtained about the patient. The reversal of atrophy will indicate that the advance of the T2DM has indeed been stopped. Additionally, the therapy, if proven, will not only help the patient get better and feel better, but it would also reduce the risk factor for AD. It has been shown by several researchers that the brain areas affected in advanced cases of T2DM are the same as those affected in AD [33-37].

In [4], it was found that the extent of changes (owing to the disease), "through the hippocampal subfields", was very much as expected for the "pathologic progression of AD pathology". Their results show that their method is promising to be a "precise diagnostic and prognostic tool". Their method may also be used as a "surrogate marker for future disease-modifying" exploratory trials as well as clinical trials.

## Atrophy in medial temporal lobe structures in T2DM patients

Atrophy in the medial temporal lobe structures, i.e. the hippocampus and the amygdala, has been shown in advanced T2DM patients [39]. In [40], it is claimed that the whole brain atrophies in T2DM disease. In fact, a very recent study [41] concluded that "the Cortical atrophy in T2DM resembles patterns seen in preclinical AD. Neurodegeneration rather than cerebrovascular lesions may play a key role in T2DM-related cognitive impairment."

It should be noted that the MRI is the method of choice used in the above recent studies, regarding brain atrophy.

## Brain cells grow in the hippocampus

In 1999, Gould, Shors et al., pointed out that neurogenesis in rats reported 30 years previous, arrived and went without much fanfare [42]. Their review uncovered work that had been published which collaborated the fact that a good number of new cells grown in adulthood transformed into neurons in the brains of many mammals, including humans.

Additionally in 1999, Gould et al., claimed that thousands of cells are generated in the hippocampus over an adult's lifetime [43]. Shors showed that new brain cells grow in our brains [44]. In fact, fresh neurons appear in our brains every day. Apparently, if the human does not challenge itself and form new neural networks, these new brain cells will die in about a week.

In ref. [45], Shors et al., claim that the adult hippocampus "incorporates new neurons into its circuitry and uses them for some function related to learning and/or related thought processes." Their growth is dependent on factors such as age, aerobic exercise, sexual behavior and alcohol consumption. It is clear that age and alcohol

consumption do contribute to brain cell degeneration. Aerobic exercise and healthy sexual behavior encourages brain cell growth.

This sub-section justifies a regimen of aerobic exercise and brain exercises to challenge the brain and hence encourage new neural networks to grow. It is a hypothesis that the sugar restrictive and gluten-free diet will help halt the advance of T2DM. The two expected outcomes of decelerating or stopping the T2DM disease and new neural network growth would predictably and synergistically work to reverse atrophy in the hippocampus.

## Hypotheses

For the proposed study, the first hypothesis is that changes in size (volume) in the hippocampus, combined with blood glucose test will provide a precise and distinctive biomarker in adults with T2DM.

The second hypothesis is that adults with T2DM will show improvement from the disease and brain cell growth in the hippocampus under the proposed new therapy of restricted glucose and gluten as well as a regimen of brain and aerobic exercises.

## Imaging Data Acquisition and Analysis

Proven methods employing the Magnetic Resonance scanner could be used to measure the volume of the brain. Twice a month measurements of patients' brain volume, who have been undergoing the non-sugar and non-gluten diet and an exercise regimen can be done.

## Selection of Study Subjects

Subjects for the proposed study could be chosen from the diagnosed patients with T2DM, who would typically be showing atrophy in the hippocampus because of their advanced stage of T2DM. A baseline scan of the patients should be performed.

## Anticipated Results and Proof of Hypothesis

If one obtains the results for which it is planned and designed, it would be discovered that there is an increase in volume of the hippocampus, as measured by published, proven structural MRI methods, in patients who had followed the restricted glucose and gluten-free diet and (brain and aerobic) exercise regimen strictly. This volume increase of the hippocampus will indicate that there is a reversal in the atrophy. Therefore, it would have been shown that gluten is a good item to remove from the diet of an advanced T2DM patient, and that the diet and exercise regimen did grow new brain cells in the hippocampus which became linked into new neural networks. Experimental medicine will indeed have another weapon in its arsenal which can be used in the fight against diabetes.

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