Virtual Scanning technology – the relationship to oxidative stress and applicability to diabetes management

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ABSTRACT. The autonomic nervous system act continuously to regulate and maintain the cellular and molecular metabolism including response to sensory inputs arising from biochemical processes. Failure of this mechanism leads to the development of pathologies such as non-retinopathy colour defects in diabetes. Virtual scanning is a cognitive technology that measures bioluminescence with significant diagnostic and therapeutic applicability. It is based upon an understanding of the relationship which exists between cognition, the autonomic nervous system and the body’s biochemistry. This article presents a review of what is already known and the gap between Virtual Scanning concept and diabetes management. The influence of stress-related effects upon the stability of the physiological systems and their effect upon diabetes mellitus is a major significant factor. The existence of correlation between bioluminescence and oxidative stress is brought to fore. There is a potential for Virtual Scanning to be used as assessment of oxidative stress. There is also a potential for experimental or observational results of Virtual...
Scanning to be validated by measurement of oxidative stress indices. Concomitant determination of the levels bioluminescence and of some oxidative stress indices will be an invaluable contribution to the debate on biophotons/Virtual Scanning theory, with a view to explore the applicability of Virtual Scanning in the management of diabetes-induced oxidative damage and colour defects.

INTRODUCTION

Diabetes is the leading cause of neuropathy in the Western world. Though current understanding of the pathophysiology is complicated and incomplete, the primary risk factor is hyperglycemia. The cerebrum is widely considered to be the location for perception, imagination, thought, judgment, and decision-making. However, there seem to be systems and neural networks, which are involved in the processes of memory and which monitor and regulate the body’s function. For instance, phantom limb syndrome is a painful diabetic neuropathy that still remains an issue in clinical practice (Hall, Carroll & McQuay, 2008).

Brain wave has been implicated as a plausible factor (Gnezdilov et al., 1995). A few mechanism-based treatments for phantom-limb pain have been proposed, based on anecdotal evidence. The current clinical management approach has not yielded consistent results. Diabetes and metabolic syndrome are complex diseases, partly because the brain contributes to their pathophysiology (Kraszewski & Cincotta, 2000). Alternative measures targeting central memory processes are being suggested (Flor, 2002).

The Virtual Scanning concept

The biochemical processes in the body generate metabolic energy, heat and/or ultra-weak light, which can be determined without altering or influencing the biochemistry and the systemic regulation (Benzinger, 1969). The brain functions synergistically with the body’s metabolism (Vahle-Hinz et al., 2007). It can be influenced by nutrition which influences the health of the body’s internal biochemistry and physiological systems (Fig. 1).

Ill health and the progression to disease are associated with visual perception deficits. For instance, it is known that a blue-yellow colour deficiency is acquired in diabetes (Shute & Oshinskie, 1986). Similarly, biochemical changes associated with disease or drug substances influence perception of colour. Changes to the levels of proteins and reactive substrates in the body cause the release...
of light albeit ultra-weak bioluminescence (Popp, 2008). Oxidative stress by reactive oxygen species and/or antioxidant enzymes such as peroxidase is a common event that can lead to the release of photons (Cilento & Adam, 1995). That this process is a contributing factor to spontaneous biophoton emission has been indicated by studies on erythrocytes as well as demonstration that biophoton emission can be attenuated by antioxidant agents. Further support is provided by studies indicating that emission can be increased by addition of reactive oxygen species (Boveris et al., 1980; Scientia Press, 2008; Ursini et al., 1989).
Protein + protein/substrate → products + bioluminescence  EQ1

Equation 1 presented above illustrates a biochemical process that represents the reaction for the generation of biophotons. This reaction occurs in both ill and normal health conditions. Examples of substrates and/or products of reactions that involve bioluminescence include antioxidants and adenosine triphosphate (ATP) respectively (Curtin et al., 2004; Dubuisson, Marchand & Rees, 2004). ATP is the ultimate of glucose consumption and metabolism. It affects body temperature, which in turn affects other biochemical processes including altered respiration, pH, and renal haemostasis. The free radicals involved in the reaction engage in transfer of electrons, which is basically bioluminescence or emission of ultra-weak light. These affect colour or heat perception and intensity.

Biophotons are also known as low-level biological chemiluminescence or ultra weak light emissions. Biophotons influence the neuroregulatory role performed by cognition, the brain, autonomic nervous system, metabolic set-points (equilibrium) and ultimately the stability of the physiological systems. When equilibrium is disturbed, disorders follow (Vahle-Hinz et al., 2007). In glucose biochemistry, the nervous and physiological systems regulate the processes of glycolysis and Pentose Phosphate Pathways (Fig. 2), which involve both ATP production and antioxidant cycles in all cells including erythrocyte (Nwose et al., 2007).

In the diabetic state, depletion of reduced glutathione (GSH) leads to a cascade of exponential oxidative activities with other co-antioxidants, including mitochondrial ubiquinone (Nwose et al., 2008) Studies have shown that injured cells will emit a higher energy (or in this context, biophotons) rate than normal cells, and organisms with illnesses will likewise emit a brighter light vis-à-vis bioluminiscence (Hugo 2008). This has been interpreted as implying a sort of distress signal being given off. Virtual Scanning is a cognitive, computer-based technology. It casts new light upon how the brain and body processes images and biochemical signals (Ewing, Ewing & Hankey, 2007; Hankey & Ewing, 2007).

Whereas other computer-based technologies are based upon the body’s interaction with its environment through x-rays, positron-emission, magnetic resonance and ultrasound; Virtual Scanning is based upon the body’s interaction with light and colour that are generated from the body’s disturbed/
undisturbed biochemical/physiological processes. It processes cognitive data to give measurements of biochemical function which quantify deviations from normal values and hence can be mathematically modeled to describe the progression of disease. Virtual Scanning technology has been investigated and recommended in Russia.

The problem

This concept of bioluminescence assessment for clinical purposes is still considered a hypothesis and has not won general acceptance among scientists who have studied the evidence. That injured cells emitting a higher biophoton rate than normal cells translates to suggest that ill health will likewise emit a

Figure 2: Schematic illustration of the initial stages of glycolysis and pentose phosphate pathways to indicate involvement of the frontline antioxidant in diabetes pathology.
brighter light (bioluminiscence) has been criticized. There is no controversy that injured cells are under higher amounts of oxidative stress activities, which is deemed as the source of the bioluminiscence. The controversy is whether oxidative stress activities truly constitutes ‘bioluminiscence signal’ or simply ‘bioluminiscence-unrelated electron-transfer system’, which is yet to be demonstrated (Davis, 2002). The debate surrounds the concept, and the difficulty of teasing out the effects of any supposed biophotons amid the other numerous chemical interactions between cells makes it difficult to devise a testable hypothesis.

There are studies on influence of age, biological rhythms, consciousness, gender as well as bilateral symmetry on the intensity of emission. The detection of peroxidation processes via analysis of emissions in the skin has also been investigated (Van Wijk & Van Wijk, 2005). There is knowledge of the importance of protein quality control system in protecting cells from oxidative damage and its relation to chronic diseases, as well as the basics of the bioluminescence as marker of the oxidant status of biological systems. It is known that oxidative stress is associated with the production of heat shock proteins or chaperones, which serves to protect against damage from oxidative stress (Van Wijk et al., 2005). The chaperones have being found to be effective as anti-diabetic adaptations with a potential application for the treatment of type 2 diabetes (Ozcan et al., 2006).

Bioluminescence resonance energy transfer (BRET) technology was developed in recent years to study protein-protein interactions. Interestingly, it has been suggested to be an important tool for identification of molecules that influence insulin receptor autophosphorylation and/or its dephosphorylation (Issad et al., 2003). It is noteworthy that intracellular ATP has bioluminescence property (EQ 1), and that BRET is a technique that determines this with a high degree of specificity and sensitivity (Curtin et al., 2004).

The Virtual Scanning technology is a diagnostic and therapeutic tool that does not require exogenous agent. This is quite different from other techniques such as BRET that requires exposure of subject to some agents. Ideally, for the results of the technology to be acceptable, they would have to be undertaken in a manner which prevented potential falsification of data. This means a formal double-blinded clinical control trial study. The question is: what form of injury or oxidative stress inducing agent would be justified in a human study, and what will be the placebo to serve as control, for a technology that requires no form of exogenous agent?
Hypothesis and objective

Given the problem against double-blind clinical trial, we opine that an alternative approach will be to determine the correlation between bioluminescence and the level of oxidative stress. This study, utilized published reports from the literature to determine the evidence of correlation between bioluminescence and the level of oxidative stress. The objective is to generate further explanations to support the postulation that oxidative stress activities constitute a ‘signalling system’ as the source of the bioluminescence, which is assessible by Virtual Scanning. Importantly, evidence of a correlation will serve to indicate that Virtual Scanning may be alternative to biochemical measures in the assessment and management of oxidative stress in diabetes.

METHODS

We reviewed the published literature using PubMed, as search engines similar to the method of Witte, Clarke and Cleland (2001). Biophotons and bioluminescence were used as search terms, with and without combination of oxidative stress as additional term. The search was unlimited to any language or period, except to studies in animals and humans at some stage. The literature search was performed on 7th September, 2008.

The number of published articles containing the search terms were recorded. The articles involving correlation studies were identified by adding ‘correlation’ to each search combination, and reviewed with regard to whether the result was affirmative. Preferential interest was given to considerations of diabetes. Related articles of a relevant result were also reviewed.

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RESULTS

Several studies have been done on bioluminescence in relation to oxidation stress, but only two did a correlation study. One of the two studies was on cell culture, while the other was on rats. A review of the latter showed that there is significant correlation between the level of oxidative stress (indicated by thio-barbituric acid reactive products) and bioluminescence intensity (Remmel’ et al., 2003). See Table 1.

DISCUSSION

We report the existence of correlation between cell injuring activities of free radicals and measurable ultra-weak light transmission. The importance of this correlation lies in the potential to measure the light transmission as an alternative to determination of oxidative stress in clinical practice. It is therefore expedient to consider the Virtual Scanning concept diabetes where hyperglycaemia insidiously induces increased free radical activities, and in relation to neuro-regulation and of the physiological systems.

**Brain Waves & the Physiological Systems:** The disruption of homeostasis of a physiological system is commonly known as stress. However, stress develops at the asymptomatic level, as a normal physiological feedback and/or feedforward response to biochemical process, but may progress to become pathological. There are acute and chronic stresses. The former includes antioxidant/oxidant imbalance. Irrespective of acute or chronic, stress involve brain wave, because psychological stress stems from the physiological (brain) system (Mark, 2008). In diabetes, oxidative stress can be induced by hyperglycaemia and there is obvious involvement of brain waves.

The brain wave is assessed by electroencephalograph (EEG) in clinical practice; and it is associated with complications of diabetes and oxidative stress. For instance, as in cerebral ischaemia (do Vale et al., 2003). However, the biochemical index of oxidative stress profile is neither employed, nor is the concept of brain wave a therapeutic target in current diabetes management. Nevertheless, there is evidence of a dynamic relationship which exists between the brain waves and the body’s physiological system (Fig. 1).

The relationship illustrated in Fig. 1 exists with biochemical processes. For instance, (1) when there is tissue injury, cyclooxygenase-2 (COX-2) is released. COX-2 is an inducible enzyme that enhances prostaglandin-induced activa-
tion of some phosphokinases inside the actual pain receptor nerve ending, which subsequently affects the sodium channels. (2) The outcome of heart failure and hypoxia-induced organ damage in diabetes is strongly attributable to the increased prevalence of anaemia and associated oxidative stress, as well as the failure of the erythropoietin-producing organs to respond to falling haemoglobin (Taniyama & Griendling 2003; Thomas et al., 2006). The latter is a factor of neurophysiology at least by dependence on the brain for the secretion of erythropoietin hormone (Soliz, Gassmann & Joseph et al., 2007).

Furthermore, the mechanism for the disposition to CVD in patients with diabetes is could involve one or more of the body’s systems (Hurst & Lee, 2003). Diabetes mellitus is associated with an increased production of reactive oxygen species and a reduction in antioxidant defenses (Bonnefont-Rousselot, 2004). Hyperglycemia toxicity mediates its adverse effects through multiple pathways. The metabolism of glucose and other sugars during hyperglycemia involve four potentially deleterious pathways including polyol, hexosamine, Protein kinase C, and glycation pathways (Zinman, 2003).

In diabetic autonomic neuropathy, the key to pathogenesis is that neither vascular nor nervous tissue requires insulin for the uptake of glucose (Duby et al. 2004). Thus, in assessing and regulating an appropriate level of blood glucose for the neural cells, the brain is unresponsive to the endocrine system (indicated by insulin level), but to the molecular biochemistry (indicated by glucose level). The implication here is that the unresponsiveness of the brain for neural uptake of glucose has the propensity to facilitate hyperglycaemia and its associated induction of oxidative stress in the neural cells. This in turn can lead to increased antioxidant activities as well as increased ATP production and bioluminescence intensity.

**Autonomic Nervous System:** The regulatory process which maintains homeostasis depends upon the coordination of the physiological systems by the autonomic nervous system. This includes the sympathetic and parasympathetic nervous system, the endocrine glands and the role performed by the various neurotransmitters. The function of the autonomic nervous system is linked to the role of receptors and neuropeptides. The homeostatic limits are clearly evident as hyper or hypo limits i.e. high or low levels of breathing, blood pressure, temperature, etc. The occurrence of DM type 1 and type 2 is associated with dysregulation of blood glucose.

The recognition of visual events through the perception of colours and shapes comprises an estimated 85% of sense perception which influences all aspects of
autonomic nervous system function ranging from the most subtle experiences to the most extreme stress-related experiences. There is evidence that colour vision deficits are not related to a problem with eye function but are instead related to biochemical fluctuations induced by hyperglycaemia (Afrashi et al., 2003). Hence the progression of disease is not linked to visible morphological changes in the retina but is instead linked to the function of the autonomic nervous system e.g. a blue-yellow colour deficit commonly encountered in patients with DM (Lobefalo et al., 1998). Although this is known, existing methods for early detection of color defects arising from diabetes have serious limitations (Daley, Watzke & Riddle, 1987).

The function of the pancreatic beta cells is influenced by the autonomic nervous system. The sympathetic nervous system inhibits the release of insulin and may be affected by stress. This leads to increased blood glucose levels (Rother, 2007), which translates to a sequence of hyperglycaemia, increased antioxidant activities as well as increased ATP production and bioluminescence intensity.

Stress in its various manifestations affects the stability of the physiological systems. As a consequence, significant changes to the reaction conditions affecting the body’s biochemistry e.g. altered mineral content, pH, temperature, etc; create the phenomenon known as insulin–resistance in the type 2 diabetic i.e. where the receptor cells no longer respond efficiently to the activating effect of insulin and affects glucose uptake by the cells (Stranges & Cappuccio, 2007).

**ATP generation and bioluminescence:** It is pertinent to bring to fore the fact that glucose is mainly used for the generation of energy in the form of ATP, which is bioluminescent. This then draws attention to glycolysis and pentose Phosphate pathways where glutathione cycle is involved (Ozcan et al., 2006).

During hyperglycaemia, reduced glutathione is depleted (Taniyama & Griendling, 2003). This causes an imbalance in cycles of vitamins C and E, as well as mitochondrial coenzyme Q (Nwose et al., 2008). Thus, there arises a cascade of cellular oxidative stress, which activates chaperones and cause release of biophotons (Popp, 2008). The latter emit (ultra-weak) light detectable by Virtual Scanning. The intensity will be proportional to antioxidant activities and/or energy generating processes vis-à-vis ill health. Hence it may be correlated bioluminescence (Remmel’ et al., 2003).

However, we were unable to find the correlation study to have been performed on diabetic human subjects. Thus, it will be of great value for clinical manage-
ment of diabetes to critically determine and establish the correlation between bioluminescence (measured by Virtual Scanning technology) and oxidative stress intensity (measured by biochemical indices) in humans. The importance is that a non-invasive Virtual Scanning technology is a likely alternative tool to biochemical measures, which require invasive collection of blood or tissues specimens.

SUMMARY

This article has highlighted the understanding that diabetes-induced oxidative stress affects the (ultra-weak) light emission and cognitive function (colour defects). This is the first report to address the possibility of using bioluminescence technology as alternative assessment for oxidative damage. Another importance of this report is the implication that oxidative stress indices can be used to validate any queries surrounding Virtual Scanning concept, as double-blind clinical control trial is not possible.

Acknowledgment

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Conflict of interest statement, if any
REFERENCES


