EMR Reduces Melatonin in Animals and People

Dr Neil Cherry
Environmental Management and Design Division - Lincoln University - Canterbury, New Zealand
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The Pineal Gland

The pineal gland, a pea-sized organ near the centre of the brain, converts serotonin into melatonin. This has a strong diurnal (daily) pattern, with high melatonin output at night and low melatonin output during the day. Alternatively, serotonin dominates the day and is lower at night. The Melatonin/Serotonin cycle is a primary physiological driver of the daily metabolic, awake/sleep cycle. Melatonin is a vital part of many of the bodies biochemical systems, including sleep and learning and is free radical scavenging in all cells and hence is a potent antioxidant with anti-aging and anti-cancer properties. It helps to protect embryonic foetuses. Melatonin mediates many hormone functions, assists in maintaining immune system health and virus protection.

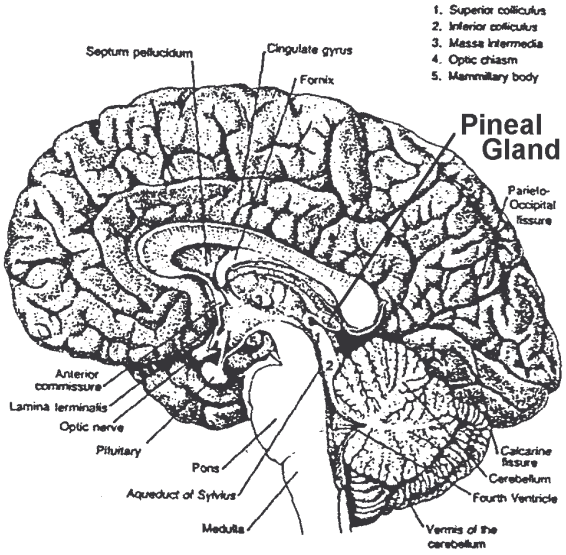

Figure 1: A schematic cross-section of the brain highlighting the pineal glad.

The light-driven daily cycle is primarily controlled by signals from the retina of the eyes that mediate the pineal function though a flow of chemical messengers. Signal messengers from the retina arrive at the receptors on the surface of the pinealocytes. Through regulation of the cyclic AMP (cAMP) pathway, the serotonin/melatonin transformation is controlled.

A key element of the cAMP pathway is calcium ions. Substances that can alter cellular calcium ions act at many levels involving many cell receptors and cellular processes. Calcium ion efflux from the pinealocytes has the effect of reducing melatonin through reducing the cAMP, Figure 2.

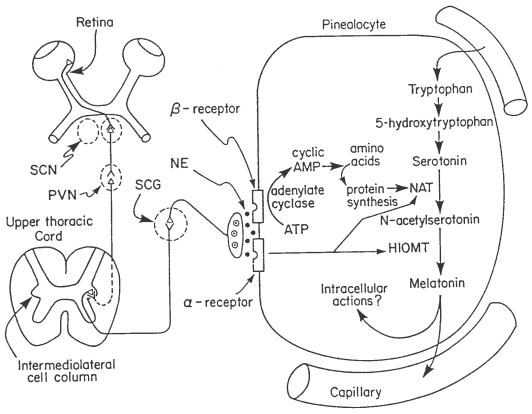

Figure 2: The biochemical mediation system for serotonin transformation to melatonin in the pinealocytes showing the signal transduction pathways from the retina to the cell and the cell receptor, through cyclic AMP and NAT to the transformation process, Reiter (1994).

EMR alters calcium ion homeostasis

Electromagnetic radiation across the spectrum alters calcium ion homeostasis in cells. The primary factor is the ELF modulation of the signal, Bawin and Adey (1976), Adey (1980). This occurs in a complex set of exposure windows. The efflux and influx for calcium ions also varies with ambient temperature, geomagnetic field strength and orientation, and signal intensity, Blackman et al. (1988, 1989, 1991). Blackman (1990) concludes that this is an established biological mechanism. Blackman et al. (1991) showed that Ca2+ efflux occurred for tissue temperatures of 36° C and 37 ° C and not at 35° C and 38° C. They comment that these could be very good reasons why experimental outcomes have been difficult to confirm in some laboratories. This shows why high SAR exposures do not produce altered calcium ions because the rise in tissue temperature takes the tissue outside the homeostatic thermal range within which calcium ion efflux/influx occurs to regulate normal cell behaviour.

The calcium ion efflux research demonstrates one of the fundamental principles of EMR research. Under given specific conditions the calcium ion efflux (positive or negative) does occur at some combination of exposure conditions, but not at a nearby slightly different set of conditions. This is because of the "window" non-linear nature of the effect with respect to modulation frequency and intensity in particular. Also, one set of conditions that produce a significant effect in one laboratory does not produce any observed effect in another laboratory because it has a different geomagnetic field. On the other hand, in real world situations workers or residents are continually passing through effective and non-effective windows of exposure.

There are great difficulties of detecting melatonin reduction in people because of the large intra-personal differences from day to day, and the very large inter-personal differences. Despite this, on average there is a dominance of exposure conditions that do cause calcium ion efflux and reduced melatonin, so that it is observed to differ in most monitored populations in the real world.

EMR Reduces Melatonin in Animals

Light-at-night and electromagnetic radiation, are proven to reduce melatonin and hence pose significant adverse health effects. The evidence for EMR is summarized here. Rosen, Barber and Lyle (1998) state that seven different laboratories have reported suppression of nighttime rise in pineal melatonin production in laboratory animals. They show that a 50 m T, 60 Hz field with a 0.06m T DC field, over 10 experiments, averages a 46% reduction in melatonin production from pinealocytes. Yaga et al. (1993) showed that rat pineal response to ELF pulsed magnetic fields varied significantly during the light- dark-cycle. They found that the rate-limiting enzyme in melatonin synthesis, N-acetyltransferase (NAT) activity showed that magnetic field exposure significantly suppressed NAT during the mid- to late dark phase.

Stark et al. (1997) observed a significant increase in salival melatonin in a group of 5 cows when the short-wave radio transmitter at Schwarzenberg, Switzerland, was turned off for three days, compared to 5 cows that had much lower RF exposure. Hence there are now at least ten independent observations of melatonin reduction in animals from ELF and RF exposure.

EMR Reduces Melatonin in People

Fifteen studies from show that ELF and RF/MW exposure reduces melatonin in people and a serotonin enhancement. Evidence that EMR reduced melatonin in human beings commenced with Wang (1989) who found that workers who were more highly exposed to RF/MW had a dose-response increase in serotonin, and hence indicates a reduction in melatonin. Thirteen studies have observed significant EMR associated melatonin reduction in humans.

They involve a wide range of exposure situations, including 50/60 Hz fields, Wilson et al. (1990), Graham et al. (1994), Davis (1997) [in a dose response manner], Wood et al. (1998), Karasek et al. (1998), and Burch et al. (1997, 1998, 1999a, 2000), Jutilainen et al. (2000) and Graham et al. (2000); 16.7 Hz fields, Pfluger et al. (1996), VDTs Arnetz et al. (1996), a combination of 60 Hz fields and cell phone use, Burch et al. (1997), and a combination of occupational 60Hz exposure and increased geomagnetic activity around 30nT, Burch et al. (1999b).

The Davis (1997) study involved residential exposures and observed nocturnal reductions in melatonin metabolite, 6-OHMS. The author states that while the effect was small it occurred at milligauss levels and followed a dose-response trend. The effect was strongest among women who were on medication that also reduces melatonin. They showed a significant dose-response trend, with a 2- , 3- and 4-fold increase in magnetic field resulting in 8%, 12 % and 15 % reductions in melatonin, respectively.

The fifteenth human melatonin reduction study is from RF exposure as reported during the shutting down process of the Schwarzenburg shortwave radio tower, Professor Theo Abelin (seminar and pers.comm.). Urinary melatonin levels were monitored prior to and following the closing down of the Schwarzenburg short wave radio transmitter. This showed a significant rise in melatonin after the signal was turned off.

Hence it is established from multiple, independent studies, that EMR from ELF to RF/MW reduces melatonin in animals and human beings.

Confirmation of the electromagnetic sensitivity of the human pineal comes from therapeutic uses of picoTesla ELF fields in the successful treatment of a range of neurological diseases, Sandyk (1993, 1994), Sandyk and Derpapas (1993) and Sandyk and Iacono (1993). These studies specifically involve Parkinson's Disease and Multiple Sclerosis. The authors identify the magneto-sensitivity of the pineal gland and the role of melatonin as the biological mechanism for this therapy.

The Health Implications of Reduced Melatonin

Melatonin has many biological effects. The melatonin receptor regulates several second messengers: cAMP, cGMP, diacylglycerol, inositol trisphosphate, arachidonic acid, and intracellular Ca 2+ concentration ([Ca2+]j). In many cases, its effect is inhibitory and requires previous activation of the cell by a stimulatory agent. Melatonin inhibits cAMP accumulation in most of the cells examined, but the indole effects on other messengers have been often observed only in one type of the cells or tissue, until now. Melatonin also regulates the transcription factors, namely, phosphorylation of cAMP-responsive element binding protein and expression of c-Fos. Molecular mechanisms of the melatonin effects are not clear but may involve at least two parallel transduction pathways, one inhibiting adenylyl cyclase and the other regulating phosphohpide metabolism and [Ca 2+]j, Vaneeck (1998).

Professor Russell Reiter, one of the world's leading medical researchers into the effects of melatonin, summarizes melatonin’s roles, Reiter and Robinson (1995), as being:

- Vital for healthy sleep, including lowering the body temperature, and assisting in maintaining health sleep states.
- Reduces cholesterol, with consequent reductions is risk of atherosclerosis and coronary heart disease.
- Reduces blood pressure and the tendency for blood clots, and hence reduces the risk of strokes.
- Scavenger of free radicals. This, along with the above factors, reduces the risk of heart attack, cancer, viral replication. Melatonin plays a vital free radical scavenging role in the brain where, because it is high in iron, has a high production rate of hydroxyl radicals (OH·). Free radical damage is now known to play a formative role in most brain disorders, including Alzheimer’ disease, Lou Gehrig’s disease, multiple sclerosis and Parkinson’s disease. While the Blood Brain Barrier (BBB) denies access to most free radical scavengers, melatonin has free access.
- Enhances the effectiveness of the immune system. Specifically enhancing the T-cells, i.e. the T-helper cells and the T-killer cells. T-helper cells have a receptor for melatonin. When melatonin is received a cascade of events is set in motion including stimulation of Interleukin-4 (IL-4) which then stimulates natural killer cells (NK), B-cells, IgA, phagocytes and T-Cytotoxic cells. The NK cells specialize in attacking cancer cells and virus infected cells.

In Professor Reiter’s book, published in 1995, he describes the evidence that EMR/EMF does reduce melatonin as a "Smoking Gun" level of proof. That is, there is considerable scientific evidence but at that time it wasn’t sufficient for scientific proof. By considering more recent information, and the extensive results of biometeorological research, and linking the melatonin research to the calcium ion research, the level of proof can be seen as causal. The multiple observations of melatonin reduction in EMR exposed populations means that EMR exposure increases the incidence of all of the conditions identified by Reiter and Robinson above, including impaired immune system, diseases from

infections and viruses, arthritis, diabetes, cancer, reproductive, neurological and cardiac disease and/or death. Epidemiological evidence of exposed workers and residential populations confirms all of these, except arthritis, have been identified to occur in EMR exposed human populations.

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