

Newly Discovered Physiological Effects of Oxytocin

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Received date: October 03, 2017; Accepted date: June 25, 2018; Published date: June 30, 2018

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Abstract

New physiological effects of oxytocin (OT) have been discovered as potentially impacting a variety of diseases, including mood and emotional disorders, autism spectrum disorder, inflammatory conditions, cardiac abnormalities, bone health and sexual behavior. OT has been dubbed “the love hormone” due to its positive effects on a number of social behaviors, including interpersonal trust, empathy, bonding and the ability to recognize emotions.

Keywords: Oxytocin; Bone health; Emotional response; Autism; Sexual behavior

Introduction

OT is a peptide hormone produced by neurons in the paraventricular nuclei of the hypothalamus, and stored in the axons of those neurons in the posterior pituitary or neurohypophysis. OT neurons also produce other peptides that have local effects, such as corticotrophin-releasing hormone (previously thought to be manufactured exclusively in the anterior pituitary) and dynorphin (endogenous opioid peptide). Historically, OT was known to be involved in labor, causing contractions of the smooth muscle of the myometrium of the uterus and, through a positive feedback mechanism, increasing those contractions until delivery [1]. Sir Henry Hallett Dale, a British pharmacologist identified its effects on the uterus during labor in 1906 [2].

Additionally, OT was known to be involved in the ‘milk let-down’ reflex, causing contraction of the myoepithelial cells around the secretory alveoli and ducts of the mammary glands, promoting the ejection of breast milk. The suckling of the infant at the breast causes sensory impulses to be relayed to the hypothalamus causing an increase in OT release, again in a positive feedback mechanism.

There are several non-neural source of OT. These include the adrenal medulla, the placenta, corpus luteum, the thymus, the retina, the pancreas, osteoblasts, and the interstitial cells of Leydig of the testes [3-11]. These new discoveries have piqued interest in the specific role of OT outside of the central nervous system.

Effects on Mood and Emotions

There recently, there have been some new discoveries involving the effects of OT on emotions and the limbic system [12-15]. It has been shown that OT has a modulatory effect on the amygdala, in both human and animal studies. Not only has it been shown to decrease sensitivity to negative images, but also decreases the fear response [12-15].

Protective Effects during Labor

OT is important for protecting the fetal brain from damage due to hypoxia during delivery. OT from both maternal and fetal sources causes a switch in the action of the neurotransmitter GABA, from excitatory to inhibitory. This causes the fetal brain to ‘shut down’ during delivery, thus reducing its vulnerability to damage from low oxygen levels [16-18].

Anti-inflammatory Effects

It is known that OT inhibits the release of certain inflammatory cytokines, thereby resulting in faster wound repair [19-21]. It has been demonstrated that social interaction increases levels of OT. This may explain why social interaction is known to accelerate wound repair [22].

Human Sexual Behavior

There are implications for the role of OT in human and animal sexual response and orgasm. Some of the studies are unclear regarding this effect. Circulating levels of OT increase dramatically in both men and women during orgasm, including during self-stimulated orgasm [23,24]. These levels remain higher than baseline for several minutes after self-arousal. It is thought that the effects of OT on smooth muscle aid in transport of both sperm and egg.

Effects on Cardiac Function

OT has a modulatory effect on both parasympathetic and sympathetic stimulation of the heart, as well as a protective effect of the myocardium following ischemia-reperfusion injury, a common complication of heart disease [25-28]. It has been shown to stimulate the differentiation of stem cells into cardiomyocytes [29].

Autism Spectrum Disorders

The use of OT clinical for autism spectrum disorders has been an area of interest in the past few years [29-31]. A young girl diagnosed with autism had dramatic improvement in her symptoms with long-term treatment with OT intra-nasally [32]. Acupuncture is known to increase plasma levels of vasopressin and OT. A study looked at the

effect of acupuncture on autism and concluded that “changes in plasma levels of arginine-vasopressin and oxytocin may be involved in mediating the effects of transcutaneous electrical acupoint stimulation” [33]. Clearly, there is an interest in exploring the use of OT for the treatment of autism spectrum disorders [34].

Post-partum Depression

OT is suspected of contributing to post-partum depression (PPD) [35,36]. Animal models support the use of exogenous OT in PPD. The research on humans is less convincing. It is known that estrogen has a modulatory effect on OT levels affecting mood [37]. It seems that PPD is more complex than simply a deficiency of OT. The studies so far have used low doses of exogenous OT. Further studies are needed to assess possible complications with higher, long-term administration of exogenous OT. While low OT levels may contribute to PPD, other factors; such as early abuse or parental abandonment contribute to the disorder as well. PPD is well known to have deleterious effects on the development of the offspring [38,39].

Effects on Bone

Both osteoblasts and osteoclasts express OT receptors [40]. OT is known to have an anabolic effect on bone. Estradiol stimulates OT secretion, and low levels of estradiol are associated with increased risk of osteoporosis. It has been shown that in amenorrheic athletes (AA), low OT levels contribute to the bone loss seen in this group [41]. In non-athletes, the nocturnal levels of OT were higher than in the AA group. These same AA had impairments in the microarchitecture of both cortical and trabecular bone. However, low OT levels in older men are not associated with an increased risk of bone loss [42].

The use of OT in treating osteoporosis is an exciting possibility and warrants further study.

Conclusion

Emerging research on the functions of oxytocin impacts how we look at a variety of disorders. There are multiple clinical implications for this research. Many of these disorders are multi-faceted and difficult to successfully treat. This is especially true of mood disorders, psychopathologies, and autism spectrum disorders. Hopefully, we will continue to find new and exciting applications for the use of oxytocin in the clinical setting.

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