

Review article

OXYTOCIN: THE HORMONE OF LOVE.

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ABSTRACT

Oxytocin was discovered by the great Italian scientist Nicholas Farriye in the year 1835. Apart from the well-known function of uterine contraction and milk ejection, it is said to play a significant role in creating an effective bond between mother and child, in trusting people, maintain eye to eye contact during a conversation. Pitocin and Syntocin are the commonly used drugs, the chemical similarity to Oxytocin makes them an ideal choice of drug for various cases for example at the time of parturition. Oxytocin is a potent molecule with a unique and unusually broad profile of biological and behavioral effects. Oxytocin acts upon receptors and tissues that are ancient and have evolved many functions. Hence, in this review we discussed the pharmacological role of Oxytocin, social effects of Oxytocin in humans, Oxytocin pathways and evolution of human behaviour, the chemistry of love and neurobiology of love.

Key words: Evolution of human behaviour, Chemistry of love, Neurobiology of love.

INTRODUCTION

Oxytocin was discovered by the great Italian scientist Nicholas Farriye in the year 1835. It has a molecular formula of $C_{43}H_{66}N_{12}O_{12}S_2$. It is predominantly a mammalian hormone. In humans, it is synthesized by specialized cells in the supraoptic and paraventricular nucleus of the hypothalamus [1]. It is said to play an important role in creating an effective bond between mother and child, in trusting people, maintain eye to eye contact during a conversation apart from the well-known function of uterine contraction and milk ejection. Most of us believe Oxytocin to be a hormone that is found only in the female counterparts; fortunately, this hormone is found in males as well. It is said to help in the maintenance of monogamous relationships. Secretion of Oxytocin was found to increase during sexual intercourse, breast feeding, during parturition. In case of male it helps in erection and ejaculation. Apart from the above mentioned functions Oxytocin helps in social recognition, calmer attitude and further more. Thereby drugs that induce the feeling of trust and attraction use Oxytocin as their prime component. This hormone is commercially available as intravenous and intramuscular injections and as nasal sprays for various purposes.

Oxytocin is that hormone that makes people fall in love. When two people of the opposite sex meet, exhibit Oxytocin surge, they are found to like mutually each other therefore falling in love. Due to this unique property of Oxytocin, it is widely called as the "love hormone" by researchers. Further, it is also believed that levels of Oxytocin tend to increase during hugging and kissing [2].

Pharmacological role of Oxytocin: Pitocin and syntocin have a chemical resemblance to Oxytocin that makes them to commonly use as an ideal drug of choice for various cases for

example at the time of parturition. Pitocin is composed of oxytocic acid/ml along with chlorobutanol, a chloroform derivative. However, medical supervision is mandatory to rule out the onset of complications [3]. The general uses of these Oxytocin drugs would include induction of labour. Under appropriate level, at the time of delivery, Oxytocin binds to the receptors present in the myometrium, activates the pathway of hydrolysis of phosphatidyl inositol and diacyl glycerol, thereby activating the same. This activation causes the release of intracellular Ca^{2+} which causes contraction of the uterus. In conditions associated with low level of Oxytocin production this process is carried out by Oxytocin drugs [4]. In case of people suffering from autism, administration of Pitocin is said to reduce repetitive behaviour and also enhances speech. Few researchers have proved the improvement of trust for persons affected by autism when they were given Pitocin nasal sprays. It also enhances eye to eye contact in these individuals. Pitocin helps in social interaction for people who suffer from schizophrenia. So Pitocin may not only combat hallucinogens and psychosis, but also make human interaction easier. Being a new field of research there is not enough evidence to prove the role of Pitocin in both autism and schizophrenia. Further, they are also used to cure problems in erectile responses, ejaculation, depression, anxiety, and stress management.

The dosage of these drugs is 10 units by intravenous route or 20-40 mU/min by Intramuscular route are injected for postpartum haemorrhage. 0.5-1 mU/min by intravenous route for the induction of labour. 10-20 mU/min is administered along with other drugs for termination of pregnancy.

Pharmacodynamics of Oxytocin: Uterine contractions are seen after 3-5 minutes and approx 1 minute of administration through intramuscular and intravenous routes respectively. A steady state of the drug is reached after 40 mins of parenteral route of administration. It is distributed throughout extracellular fluid compartment of the mother; small amounts may cross the placental barrier and reach the fetus. Metabolism takes place rapidly via the liver and plasma by the enzyme Oxytocinase a few steps of metabolism also occurs via mammary gland. It has a half-life of 1-5 minute. Kidney and liver help in the elimination of Oxytocin drugs[5], unchanged form of this medication are rarely excreted in urine [5]. Overdose may cause tetanic uterine contractions, impaired blood flow to the uterus, uterine ruptures, seizures and amniotic fluid embolism.

The side effects are nausea or vomiting, memory problems or confusion, runny nose, sore throat, or coughing, severe headaches, hallucinations, vomiting, confusion, seizures, severe hypertension and irregular heartbeats [5],

Social effects of Oxytocin in humans: Jennifer A. Bartz [6] proposed that exogenous Oxytocin can be viewed as altering the primary processing of social stimuli, for example the salience of interpersonal cues that in turn could produce a wide variety of behavioral effects depending on situational and/or dispositional factors.

Oxytocin pathways and evolution of human behaviour: Oxytocin is a powerful molecule with a unique and unusually broad profile of biological and behavioral effects. Oxytocin acts on receptors and tissues that are ancient and have evolved many functions. Understanding this system provides a window into the evolution and epigenetics of the human brain. Abundant evidence indicates that individual differences in experience, with effects on health and behavior across the lifecycle, are shaped by caretaker-offspring interactions [7]. The nervous system seems to be especially sensitive in early life to the presence or absence of peptides, such as Oxytocin and vasopressin, with epigenetic consequences that may help to explain individual differences in behavior and coping strategies. Although beyond the scope of this review, there is now little doubt of the epigenetic importance of Oxytocin and vasopressin. Thus, medical manipulations or even rearing procedures that may influence these hormones, especially in early life, should be applied with caution [8]. Throughout vertebrate evolution, the effects of Oxytocin-like molecules have been integral to survival and reproduction. In modern humans, the functions of Oxytocin facilitate birth and both directly and indirectly influence brain anatomy, allowing the elaboration of the human neocortex and thus cognition and language. The presence of Oxytocin physically remodels the mammalian brain and body. Oxytocin plays a role in sensory, autonomic, integrative, visceral, and motor systems. It helps to tune the emotional nervous system in early life. Oxytocin may contribute to provide a sense of safety or trust. Oxytocin protects and directly heals tissue, with therapeutic consequences that are only now being discovered. Simply put, I suggest here that Homosapiens, with their high level of dependence on social behavior and cognition, could not have evolved without Oxytocin.

The chemistry of love: There are many different types of love: sexual, romantic, platonic, filial, maternal, paternal, spiritual, love of self, love of country, love of possessions to name a few. Love for our mother, our first love, could be the pivotal love around which we build our ability to love in every other way. Interesting studies have been conducted on voles. The prairie vole, or prairie dog, is one of only a few mammals that are monogamous – they mate for life with one partner. Both parents nurture their young, and the adult pair spends most of their time together. The montane vole, a close cousin of the prairie vole, on the other hand, is very promiscuous; its life being filled with one - night- stands and is uncommitted to either a partner or their own offspring. Very little genetically separates these two animals only the presence of receptor sites for Oxytocin in the area of the brain responsible for reward and pleasure, the limbic system, being one that the prairie vole has but the montane vole does not. All of the neurotransmitters, the chemical messengers, that are involved in love and loving, care and being cared for and our emotional state arise from the limbic system. This is an 'old' part of the brain, sometimes referred to as the 'mammalian' brain. Responses that arise from this part of our brain are not under the control of our 'thinking' brain, or the neocortex. Oxytocin is produced in the hypothalamus, a part of the Limbic System, and sequestered in the posterior pituitary gland to be released in a pulsatile manner when stimulated. This stimulation could occur from sharing a meal with friends; in response to a hug from a friend; while making love; during birthing and immediately after birth; and it is an integral part of breast feeding. Oxytocin is described as the 'hormone of love' because it is consistently involved in all forms of love. All of these releases of Oxytocin occur during a form of love. The hormones present at the same time as the Oxytocin release determine how this love is directed. For example, during a shared meal with friends, Oxytocin causes sociability; during romantic love Oxytocin in the presence of high levels of dopamine and low levels of serotonin stimulates a desire for caring love making. When high levels of testosterone are present it causes sexual lust. In the presence of prolactin, the love is directed at nurturing and "mothering", and sexual desire is suppressed. Oxytocin also causes a reduction in stress and later stress- related diseases [8]. For Oxytocin to have an effect on behaviour it must be available to the brain and for the brain to have receptors for it. Oxytocin cannot pass from the peripheral blood stream back into the brain, i.e., artificially administered Oxytocin cannot enter the brain and cause behavioural effects. Around the time of birth estrogen, progesterone, and prolactin blood levels are reaching all time high in the mother, and circulating into the fetus. Beta-endorphin has also been steadily rising throughout pregnancy peaking at high levels during labour in response to the pain felt, and is also generated by the fetus. Oxytocin is released in a pulsatile manner periodically throughout the pregnancy by both mother and fetus while labour is characterized by intense pulses of Oxytocin that cause uterine contractions.

Neurobiology of love: Love is a complex neurobiological phenomenon, relying on trust and belief as well as brain reward activity, i.e., limbic processes. These processes

critically involve Oxytocin, vasopressin, dopamine, and serotonergic signaling. Moreover, endorphin and endogenous morphinergic mechanisms, coupled to nitric oxide autoregulatory pathways, play a role. Naturally rewarding or pleasurable activities are necessary for survival and appetitive motivation, usually governing beneficial biological behaviors like eating, sex, and reproduction. Thus, love and its rewarding pleasure are much needed. Love and social bonding employ a push-pull mechanism that activates reward and motivation pathways. Simultaneously, brain circuits that facilitate critical social assessment and negative emotions, as well as physical and mental stress, or "cognitive dwelling", i.e., 'cognitive constipation' [9] get down regulated. This down regulating property of love may also include further physiological phenomena. However, early phases of love, such as falling in love and its related arousal and more pronounced behaviors and molecular signaling activities, are distinct from later stages or even long-lasting relationships. Nonetheless, a broad basis of common signaling and beneficial neurobiological features exist with connection to the love concept, thereby combining physiological aspects related to maternal, romantic or sexual love, and attachment, with other healthy activities and neurobiological states. Medicine can make use of this concept, i.e., mind/body or integrative medicine.

Many questions remain open. For example, would acute exposure to Oxytocin promote a search for social contact, while chronic exposure might trigger social satiety or safety and reduce social motivation? What about the other signaling pathways and neuropeptides? We attempted to answer some of these questions on possible solutions for related medical problems or applications. Undoubtedly, love, pleasure and lust, have a stress-reducing and health-promoting potential.

CONCLUSION

Oxytocin is a potent molecule with a unique and unusually broad profile of biological and behavioral effects. Apart from its physiological and pharmacological role, oxytocin also plays vital role in social relations, emotional bonds, biological and neuro chemistry of love. Further studies are required to validate these effects.

Conflict of Interest: Nil

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