

DISCUSSION

Dentists should be aware of all the medications that patients take before planning for implant therapy. Both PPIs and SSRIs have a deleterious effect on the success of dental implants. It is possible that AHTNs offer a beneficial impact on the longevity of implants, although the results of this review were based on just 1 study.

Chappuis V, Avila-Ortiz G, Araújo MG, et al: Medication-related dental implant failure: Systematic review and meta-analysis. *Clin Oral Impl Res* 29:55-68, 2018

Reprints available from V Chappuis, Dept of Oral Surgery and Stomatology, School of Dental Medicine, Univ of Bern, Bern, Switzerland; e-mail: vivianne.chappuis@zmk.unibe.ch

MASTICATION

Effect of mastication on cognitive function



BACKGROUND

Mastication is the process whereby food is crushed and ground up to increase its surface area and allow for more effective processing by digestive enzymes. Mastication is controlled by the central nervous system (CNS) and is associated with various neural networks in the brainstem and brain regions that control and create complex masticatory patterns. A critical analysis was done into how mastication is related to neuronal activities in various brain areas and the method by which it increases cerebral blood oxygen levels of the hippocampus and prefrontal cortex and thereby contributes to learning and memory processes.

METHODS

Articles on mastication were sought in the Scopus, PubMed, ScienceDirect, Clinical Key, and Google Scholar databases covering the years from 1939 to 2015.

RESULTS

Conveying Information Through Mastication

The hippocampus is a CNS region where learning, spatial memory, and the formation and retrieval of episodic memories reside. Multiple neural circuits connect mastication to the hippocampus. These help to maintain the cognitive functions of the hippocampus during mastication. It's hypothesized that 2 main pathways exist: the neuronal and humoral pathways.

The primary sensory somata carry nociceptive and proprioceptive sensations from the oral cavity to the CNS. They are found in the mesencephalic trigeminal nucleus and trigeminal ganglion. The mesencephalic trigeminal nucleus axons responsible for voluntary mastication end in trigeminal motor nuclei, supratrigeminal regions, and infratrigeminal regions. The central axons of the trigeminal ganglion terminate at spinal and principal sensory nuclei of the trigeminal nerve and sensory nuclei. The afferent fibers of the mesencephalic primary sensory neurons also reach the brainstem reticular formation, which regulates

the sensory input of the reticular activating system (RAS) to higher brain centers. Together the reticular formation and RAS are needed to stimulate the brain during conscious learning, perception, and attention. The sense of perception of the oral cavity may therefore influence memory and the ability to learn.

Various growth factors are produced in the salivary glands, with increased production during mastication. If occlusal disharmony is present, it can alter these levels. An alteration in the level of nerve growth factor (NGF) caused by malocclusion may be associated with changes in the negative feedback system of the hypothalamic-pituitary-adrenal (HPA) axis in the hippocampus. As a result, the secretion of corticosterone may increase, suppressing neuron excitability and causing neuron death. With mastication, metabolic activity increases, stimulating the autonomic nervous system and oral tissues. In turn, the partial pressure of carbon dioxide in the cortical sensorimotor neurons increases, resulting in increased blood flow to the brain and oral tissues. Multiple regions of the brain become activated during mastication, so this action can influence hippocampal function through numerous neural pathways.

Evidence Linking Mastication, Cognitive Function, and Memory

A study of 3063 Chinese adults over age 60 years analyzed the relationship between missing teeth and cognitive functions. Having an average of 18.7 teeth missing was associated with dementia and having 10.2 missing teeth was associated with mild cognitive impairment, but those missing an average of 9.2 teeth were cognitively normal.

A study of mastication's effects on cognitive function and memory revealed substantial improvement in both delayed and immediate recall of formerly learned words in patients who chewed versus those in a non-chewing control group. The learning performance of the chewing group increased a minimum of 30%.

Students in 4th and 5th grade participated in a study of the positive effects of chewing during a comprehension test. They were exposed to short stories and told to learn as much as possible, then were asked to recall and write down what they remembered 5 minutes and 24 hours later. Gum chewing had no effect on their performance at 24 hours but improved recall and better writing ability were noted after the 5-minute delay for patients who chewed gum.

An assessment of cognitive function was done in older adults with normal cognitive status. The mean Mini-Mental State Examination results were compared between a group who wore dentures and one having all natural teeth. A remarkably higher score was found for those having natural teeth than for those with complete dentures.

A study of healthy adult individuals in age-related cognitive decline investigated the number of remaining teeth in relation to the gray matter volume in their brains. Fewer teeth status was related to diminished gray matter around the hippocampus and frontal lobe volume.

Several animal studies have also evaluated mastication's relationship to cognitive function or working memory. Chewing tended to improve the ability to learn and increase the number of dentate gyrus cells in the hippocampus. Difficulty with motor and sensory information processing was noted when multiple teeth were lost.

Stress and Occlusal Disharmony

Stress activates the autonomic and neuroendocrine systems via the HPA axis, thereby releasing hormones and corticosteroids. Mastication alters HPA axis activity and influences the autonomic nervous system. The changes that resulted indicate that mastication can be a stress coping behavior that reduces stress-induced disorders.

Occlusal disharmony and mastication can also be affected. Learning-related c-Fos expression was significantly reduced

when reduced mastication resulted from occlusal disharmony. In addition, when occlusal disharmony was corrected, cortisol and corticosterone levels returned to base values. In older adults, working memory function was tested in relation to mandibular displacement. Impaired memory function was noted in elderly patients who had artificially produced occlusal disharmony.

Animal studies have also investigated occlusal disharmony and mastication. One tested animals' ability to run a maze when occlusal disharmony is present. A radical decrease in the density of dendritic spines and pyramidal neurons and an increase in astrocytes and hypertrophy of hippocampal CA1 field were noted and correlated with impaired spatial memory. Overall, it was determined that mastication preserves memory and learning when the occlusion is normal but can adversely affect those functions when there is occlusal disharmony.

Clinical Significance

Mastication has been proved to maintain the peripheral sensory input in general health and increase blood supply to various brain regions. The result is better cognitive function. Further studies are needed to determine what else might be impacted by good masticatory function and normal occlusion compared to their compromised function. It appears that the ability to chew is essential to good cognitive function.

Krishnamoorthy G, Narayana AI, Balkrishnan D: Mastication as a tool to prevent cognitive dysfunctions. *Jap Dent Sci Rev* 54:169-173, 2018

Reprints available from AI Narayana, Dept of Prosthodontics and Crown & Bridge, Manipal College of Dental Sciences, Manipal Univ, Manipal, 576104 India; e-mail: prostho.manipal@gmail.com

MICROBIAL ECOLOGY

The oral microbiome



BACKGROUND

Humans have a complex microbiome consisting of usually over 1000 species of bacteria, fungi, archaea, and viruses. The microbiome is formed through a highly selective process that begins at birth and continues throughout an individual's lifetime. The balance between the different types of organisms is established as a result of the interactions of the characteristics of the various

habitats in the body and aspects of the individual's lifestyle, including dietary patterns, the frequent consumption of sucrose, smoking, and the use of antimicrobials and vaccines, among others. Recent studies of the nature of the human oral microbiome and its beneficial and detrimental aspects, including factors that can cause imbalance between the organisms dwelling there, have contributed to better understanding of this important topic.