Contemporary Relevance of Occlusion and Mastication

The evolution of new dental technologies, such as three-dimensional (3D) image manipulation, computer-aided design/computer-assisted manufacture (CAD/CAM), and new ceramics, are having a profound impact on treatment planning in oral rehabilitation. Yet the fundamentals of mastication, which are crucial determinants of optimizing treatment outcomes, are often overlooked. The importance of an optimal dentition for mastication is undergoing renewed recognition of its clinical significance beyond the commonly accepted importance of the arrangement of the teeth for esthetics and function.

It is accepted that the dentition is a key feature for enhanced mastication, swallowing, diet, nutrition, and speech clarity. Indeed, anterior tooth arrangement, form, color, and character improve esthetics and individual social interaction, confidence, and quality of life. However, in addition, data are emerging that suggest that enhancing mastication may support maintenance of higher-level cognitive skills.[1–4]

This research represents a paradigm shift for all aspects of oral rehabilitation and emphasizes an additional dimension of clinical responsibility. It adds to the significance of maintaining teeth for function and esthetics and acknowledges the importance of prosthodontic rehabilitation as a requirement for general health.

Mastication and Cognitive Health

Animal and human studies have shown associations with mastication and cognitive function through the hippocampus and its role in individual learning and memory.[1–4] Decreased mastication has been shown to be an epidemiologic risk factor for dementia and decreased spatial memory associated with decreased hippocampal neurons. The question of whether this is reversible is of particular importance and there is some evidence for this: *(1)* Data suggest that mastication influences memory processes by reducing endocrinologic and autonomic stress responses, leading to increased activity of the hippocampus and prefrontal cortex, thereby increasing cognitive processing. *(2)* So-called "abnormal" mastication (eg, caused by experimentally altering the occlusion through tooth extraction or reducing the height of natural crowns) induces chronic stress, decreases learning capacity, and reduces spatial memory and hippocampal neurons in animals.[4,5] Interestingly, restoring masticatory function with artificial crowns in aged mice counteracted the reduction in spatial memory and hippocampal neuron function.[5] This outcome cannot be directly linked with humans, but raises important issues. *(3)* In an older Swedish population sample, a robust association was found between cognition and self-reported chewing ability.[6] Whether the participants chewed with natural teeth or prostheses did not contribute significantly to cognitive impairment as long as they had no chewing difficulty.

This was also recognized as a significant association by Paganini-Hill and colleagues, who emphasized the importance of adequate teeth or prostheses (removable or fixed) to support mastication in order to reduce the risk of cognitive decline and development of dementia.[7]

In addition, preserving the occlusion of the teeth has more general health-related implications associated with the need to preserve masticatory function. Within this context, the significance of the shortened dental arch needs consideration, having been comprehensively evaluated since its description[8]; however, the relationship with function and the implications that 20 teeth are needed for mastication requires clarification. This number of occluding pairs of teeth, as well as its importance for function, has other important implications and defines an additional dimension of the shortened dental arch concept.

Morita et al reported that the progressive loss of teeth in a Japanese population sample older than 80 years of age influenced diet and nutrition and affected daily activities and mental health.[9] Of significance was that longevity and tooth loss influenced older men in particular, who had statistically significantly shorter survival with fewer than 20 teeth. In the women, the presence of 20 or more teeth did not influence survival.

In a similar context, Osterberg et al reported on a population of 75-year-olds over a 7-year period.[10] There were significant associations between number of teeth and cognitive and cardiovascular function, muscle strength, hearing, and visual ability. The association varied with the risk factor, but the authors also identified a higher mortality for both genders with fewer than 20 teeth and a relatively lower mortality for women than men.[10]

In a further study of this cohort,[11] the strength of association between tooth number (greater than or equal to 20 teeth) was investigated, and statistically significant data confirmed the number of teeth to be *(1)* an independent predictor of mortality and *(2)* independent of general health factors, socioeconomic status, and lifestyle. The data also suggested a direct correlation of a 4% decrease in mortality for each remaining tooth at the age of 70. As well as these significant associations, a later study confirmed significant statistical associations with increased obesity and edentulism, particularly among women 55 to 75 years old, and a weaker association for men.[12]

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Some animal studies have investigated diet-induced obesity in mice, which was found to correlate with a decrease in the immune response and an increase in severity of periodontal disease.[13] Notwithstanding the limitations of correlations between animal and human data, it appears there are complex changes in the immune responses in relation to diet and obesity.

Hypothesis

An inverse correlation has been identified between mastication and corticosteroid level, which led Ono and colleagues to suggest a hypothesis that *(1)* suppression of the hypothalamic–pituitary–adrenal (HPA) axis with mastication-induced stimulation reduced circulating corticosteroid; and *(2)* this is significant for preservation of cognitive function.[2]

It appears that mastication may induce changes in defective cognitive function and operate through the HPA axis and hippocampal neuronal processes. For instance, patients with Alzheimer's disease (AD) have increased levels of cortisol, and long-term cortisol elevation may impair cognitive function.[14] Of relevance is that mastication preceding cognitive task acquisition leads to increased learning and memory. This has led to a provocative hypothesis that mastication appears to provide "medication-free" protection against the development of senile dementia and stress-related disorders.[2]

Improvement of learning and memory after chewing could be related to the mastication-induced increase of blood flow in different cortical areas, among them the prefrontal cortex and the hippocampus. These areas are involved in cognition and learning.[4] Adequate cerebral blood flow (CBF) is crucial to meet the metabolic demands necessary for cognitive activity[15]; in this context, AD has been reported to be associated with a reduced CBF in several brain areas. Physical exercise increases CBF as well as cognitive function and reduces the risk of dementia and AD in humans. This effect has been hypothetically related to neurotrophic factors, autonomic regulation of endothelial function, angiogenesis, and neurogenesis. Furthermore, exercise leads to reduction of several markers of AD neuropathology, among them amyloid-beta (Aβ) deposition.[16] It can therefore be hypothesized that the positive effect that mastication has on cognitive function also occurs as a consequence of the increased CBF.

Nevertheless, it is important to acknowledge that dementia and AD arise from an interplay of multiple risk factors, including cardiovascular diseases, arteriosclerosis, head trauma, diabetes, and genetic predisposition. Further study is required to clarify the relative importance that poor mastication has on this interplay and whether optimal mastication may actually help to prevent cognitive impairment.

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