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# THE PROBABILITY OF CHANGING THE VOLUME OF VARIOUS TYPES OF MEMORY IN YOUNG PEOPLE AFTER TOOTH EXTRACTION

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In this work, a study of the volume of different types of memory in young people after tooth extraction for orthodontic indications and as a result of untimely caries treatment was carried out. Loss of teeth leads to deterioration of the chewing process, which improves blood supply to certain brain areas, including the hippocampus. In the process of chewing food, stimulating sensory impulses enter the hippocampus, whose function is to remember and encode the environment and spatial memory. Reducing the number of teeth reduces the level of such stimulation. Extraction of teeth at an early age also causes chronic stress that affects interpersonal interaction, which may later contribute to the impairment of some cognitive functions, particularly memory.

**Key words:** loss of teeth, memory impairment, cognitive disorder, logical memory, mechanical memory, auditory memory, visual memory, auditory-motor memory, combined memory.

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# ЙМОВІРНІСТЬ ЗМІН ОБ'ЄМУ РІЗНИХ ВИДІВ ПАМ'ЯТІ У ОСІБ МОЛОДОГО ВІКУ ПІСЛЯ ВИДАЛЕННЯ ЗУБІВ

У даній роботі проведено дослідження об'єму різних видів пам'яті у осіб молодого віку після видалення зубів за ортодонтичними показаннями та внаслідок несвоєчасного лікування карієсу. Втрата зубів призводить до погіршення процесу жування. В процесі пережовування їжі в гіпокамп, функцією якого є запам'ятовування та кодування довкілля, а також просторова пам'ять, поступають стимулюючі сенсорні імпульси, а зменшення кількості зубів – знижують рівень такої стимуляції. Видалення зубів у ранньому віці також викликає стан хронічного стресу, що впливає на інтерперсональну взаємодію, що згодом може сприяти порушенню деяких когнітивних функцій, зокрема пам'яті.

**Ключові слова**: когнітивні функції, зуб, логічна пам'ять, механічна пам'ять, слухова пам'ять, зорова пам'ять, моторно-слухова пам'ять, комбінована пам'ять.

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Memory impairment (episodic or permanent) is one of the most common disorders that are familiar to almost everyone and can significantly impair the quality of life.

This cognitive disorder often occurs in elderly people because of age-related changes in the body due to atherosclerosis, micro stroke, and Alzheimer's disease [11]. However, memory problems also occur in young people, which are associated with brain damage, diseases of internal organs, chronic intoxication of the body, violation of the daily regimen, adverse effects of external factors (stress, nervous and emotional fatigue, when physiological processes related to memory are blocked). Reducing the number of teeth leads to a deterioration in various types of memory, namely, the transformation of short-term memory into a long-term one. In addition, episodic memory indicators are associated with the force of the bite when chewing: 19 % of episodic memory function can be predicted by determining the mobility of the jaw and the strength of the bite.

According to the literature review, extraction of teeth at an early age causes chronic stress, which affects interpersonal reciprocity and, subsequently, the state of cognitive functions [2].

Many hypotheses are considered for explaining the mechanisms of the relationship between chewing ability and cognitive function. According to one hypothesis, effective chewing of food leads to an increase in digestion efficiency and memory preservation [5]. According to another hypothesis, chewing increases the level of brain activity [4]. It is also possible that active chewing helps to reduce stress and/or pain [14]. It is known that stress, whether caused by pain or not, negatively affects cognitive abilities [15]. Tooth loss leads to a deterioration in the chewing process, which improves blood supply to various parts of the brain, including the hippocampus [6]. In the process of food chewing, stimulating sensory impulses arrive in the hippocampus, whose function is memorising and encoding the environment, as well as spatial memory, so a decrease in the number of teeth reduces the level of such stimulation [11, 13, 15]. However, if the chewing process is not disturbed during losing of teeth, cognitive impairments may not occur.

The extraction of teeth at a young age, as a rule, is associated with the untimely treatment of complicated caries or treatment of bite pathologies, in which non-removable orthopedic structures (bracket systems) are used, suggesting the presence of a reserve space in the jaw.

**The purpose** of the study was to determine the volume of various types of memory in young people with extracted teeth, depending on the number and group of the extracted teeth.

**Materials and methods**. The objects of our study were 74 people aged 18–21 years. The main group consisted of 46 people (20 females, 26 males) with extracted teeth (from 1 to 4 teeth): according to orthodontic indices, 31 people, as a result of untimely treatment of caries, 15 people (Table 1). The period after the tooth extraction was during 1–4 years. There were 7 removed canines, 28 premolars, and 58 molars, considering with type of tooth. The control group consisted of 28 people (13 females, 15 males) without extracted teeth.

Table 1

**Distribution of patients into groups, depending on the number of extracted teeth**

| Gender | Main group | | | | Control group |
|---|---|---|---|---|---|
| | Number of extracted teeth | | | | |
| | 1 | 2 | 3 | 4 | |
| Males | 10 | 7 | 5 | 4 | 15 |
| Females | 9 | 6 | 3 | 2 | 13 |
| Total | 19 | 13 | 8 | 6 | 28 |

To study different types of memory, we used the method of V.V. Voloshina, and L.V. Dolinskaya [1].

A. Research method for logical memory: the necessary material – two rows of words: in the first row, there are semantic connections between words (doll – play, chicken – egg, scissors – cut, etc.). In the second row, they are absent (beetle – chair, scallop – earth, compass – glue, etc.). In the course of performing the work, the pairs of words of the first and second rows are read to the subjects (the interval between the reading of the pairs of words is 5 seconds), and after 10 seconds, the memorized phrases are reproduced by them in writing.

B. Research method for auditory memory: the necessary material is a number of words for memorizing by ear – an airship, a lamp, an apple, a pencil, etc. words are read for examined persons with an interval of 5 seconds, after 10 seconds they reproduce them in writing.

C. Research method for visual memory: the necessary material – a series of words for memorization with visual perception – an airplane, a kettle, a moth, etc., 10 words at the rate of 10 seconds for each word are shown to the subjects, then they reproduce them in writing.

D. Research method for motor-auditory memory: the necessary material – a series of words for motor-auditory perception – a ship, a dog, a desk, etc. The examined persons are read the words, then repeat in a whisper and "draw" in the air, after these words are reproduced in writing.

E. Research method for combined memory: the necessary material – a series of words for combined perception – a wolf, a barrel, skates, etc. The examined persons are shown the written words and read them aloud while the subjects repeat each word in a whisper and "draw" in the air. Then, the words are reproduced in writing.

The volume of each of the types of memory is calculated by the formula: Memory=A/B×100 %, where A – is the number of reproduced words, and B – is the total number of words in a row.

**Results of the study and their discussion.** As a result of the research in 74 people was determined the dental status.

The subjective examination was carried out. They had not in anamnesis traumatic brain injury, neurosurgical interventions or other diseases, which lead to cognitive disorders. An objective examination of patients was carried out with the determination of the number of extracted teeth and types of teeth. The examined persons have good functional condition of the organs of vision and hearing.

The first group included 19 people with one extracted tooth, in the study of different types of memory was determined that the highest measures 85.2±1.08 % correspond to the volume of visual memory and combined memory – 80.1±0.95 %. In the control group of persons, the measures of the volume of visual memory are 87.8±0.58 % and the measures of combined memory accounts for 81.9±0.64 % (Table 2).

The lowest measures in the first group correspond to the volume of mechanical memory 50.8±1.23 %. Respectively, in the control group of persons, the measures were 52.1±0.70 %.

Table 2

**The measures of the volume of various types of memory depending on the number of extracted teeth**

| Type of memory | Measures of the volume of various types of memory (%) | | | | |
|---|---|---|---|---|---|
| | Groups of patients | | | | Control group |
| | 1 | 2 | 3 | 4 | |
| Logical | 60.9±1.39 | 59.3±0.40 | 58.1±0.55 | 57.8±0.56 | 61.2±0.79 |
| Mechanical | 50.8±1.23 | 49.3±0.43 | 47.8±0.65 | 46.5±0.23 | 52.1±0.70 |
| Auditory | 77.±1.51 | 76.±0.51 | 75.4±0.45 | 74.9±0,50 | 77.8±0.91 |
| Visual | 85.2±1.08 | 84.1±0.41 | 83.6±0.35 | 80.9±0.50 | 87.8±0.58 |
| Motor-auditory | 68.7±1.17 | 66.1±0.48 | 64.2±0.41 | 62.4±0.35 | 69.3±0.96 |
| Combined | 80.1±0.95 | 78.7±0.44 | 77.4±0.32 | 76.3±0.25 | 81.9±0.64 |

In the first group of persons has been observed a slight decrease in logical memory by 0.3 % and auditory-motor memory by 0.6 %. Measures of the volume of visual memory are less 3.2 %, in comparisons to the control group of persons.

In the second group includes 13 people, which had two extracted teeth. In the study of different types of memory was determined that the highest rate correspond to the volume of visual memory is 84.1±0.41 % and combined memory is 78.7±0.44 %. In the control group of persons, the volume of visual memory is 87.8±0.58 %, respectively the volume of the combined memory is 81.9±0.64 %.

In the second group, the lowest rates correspond to the volume of mechanical memory 49.3±0.43 %. Respectively, the control group of persons corresponds to 52.1±0.70 %.

In the second group of persons was a slight decrease in the volume of auditory memory by 1.1 %, and the volume of logical memory by 1.9 % compared with the control group of persons. The measures of the volume of visual memory are less than in the control group of persons by 3.7 %.

The third group included 8 people, which had three extracted teeth. The study of different types of memory determined that the highest rates 83.6±0.35 % correspond to the volume of visual memory. In the control group of persons, the measured volume of visual memory is 87.8±0.58 %.

In the third group, the lowest rate 47.8±0.65 % corresponds to the volume of mechanical memory. In the control group of persons, this measure is 52.1±0.70 %. In the third group of people was a slight decrease in the volume of auditory memory by 2.4 % and the volume of logical memory by 3.1 % of Measures volume of volume combined memory is less by 4.5 %, auditory-motor memory is less by 5.1 % in compared to the control group of persons.

The fourth group included 6 people which had four extracted teeth. The study of different types of memory determined, that the highest rates correspond to the volume of visual memory of 80.9±0.50 %. In the control group, this indicator is equal to 87.8±0.58 %. The high rate of 76.3±0.25 % in this group also corresponds to the volume of the combined memory. In the control group, this measure is 81.9±0.64 %. The lowest rates 46.5±0.23 % in the fourth group correspond to the volume of mechanical memory. In the control group of persons, the measure is 52.1±0.70 %. In the fourth group of persons was observed the lowest rates of the volume of auditory memory by 2.9 % compared with the control group.

The greatest decrease measures by 6.9 % correspond to the volumes of motor-auditory and visual memory in comparison with the control group of persons.

The most frequent changes were observed in measures of visual and motor-auditory memory. It was determined, that the one tooth extracted, leads to a decrease in the volume of visual memory by 2.6 % and also noted a decrease in the volume of motor-auditory memory by 0.6 %. In cases of four tooth extraction was observed a decrease in the volume of both visual and motor-auditory memory by 6.9 %. More sustainable are auditory and logical memory. The volume of auditory memory decreases by 0.7 % after the one-tooth extraction.

Decreasing the volume in auditory memory by 2.9 % was determined after the four-tooth extraction. From the side of logical memory are noted as insignificant changes. The volume of logical memory is decreasing by 0.3 %, after the one-tooth extraction. The dynamics of measuring the volume of various types of memory does not depend on the types of teeth and localization of the extracted teeth (canines, premolars, and molars).

Our results are consistent with literature data on various types of impaired memory after tooth extraction. After tooth extraction, the asymmetry of proprioceptive afferentation of the masticatory muscles leads to functional disorders of the trigeminal system and cortical–subcortical interactions which can

influence higher mental functions, including memory [7, 8]. Both animal and human research have shown, that mastication maintains cognitive function in the hippocampus, a brain area, that is important for learning and memory.

Active mastication rescues the stress-attenuated process of the hippocampal memory process in animals and attenuates the perception of stress in humans by suppressing endocrinological and autonomic responses to stress.

Active mastication further improves the performances of sustained cognitive tasks by increasing activation of the hippocampus and prefrontal cortex, brain areas that are necessary for cognitive processing [3, 12].

Abnormal mastication caused by experimental occlusal disharmony in animals produces chronic stress, which in turn suppresses the ability for spatial learning. The negative correlation between mastication and corticosteroids has given the hypothesis about the suppression of the hypothalamic-pituitary-adrenal axis (HPA) by mastication partial stimulation contributes to preserving cognitive functions that are associated with mastication [10].

Experimental animal research confirms the effect of tooth loss on memory impairment, neuronal activity, synaptic protein levels, glia activation and pyramidal neuron loss.

Two-month-old mice were divided into a control group and a tooth loss group. In the tooth loss group, were extracted maxillary molars from both sides, while no teeth were extracted in the control group. The results of animal research suggest that in the tooth loss group, was observed memory impairment and decreased neuronal activity and the levels of synaptic proteins in the hippocampus and in the cortex [15].

Besides that, tooth loss increased the activation of phosphorylated c-Jun N- terminal kinase (JNK), heat shock protein 90 (HSP90) and glial activation and reduced the number of pyramidal neurons in the hippocampus. Obviously, tooth loss in young mice decreases the activity of neurons, synaptic protein levels and also pyramidal neuronal cell loss, which leads to memory impairment.

In patients of the main group, the greatest number of extracted teeth were molars over 60 %. According to laboratory research, the loss of a molar can cause the development of cognitive impairment, but the main mechanism of these disorders is not clear [9].

There are considered several hypotheses occurrence of cognitive impairment as a result of occlusal support loss. A mechanical pathway, in which tooth loss leads to functional disorders of the masticatory-motor system. The activity of mastication organs and cerebral circulation is reduced. A decrease in afferent stimulation of peripheral receptors (in the periodontal membrane), is a decrease in the strength of connections between neural pathways and caused degeneration of the corresponding parts of the brain. An aggravation pathway, in which tooth loss exacerbates existing neurodegenerative changes. Tooth loss can also accelerate nerve damage through apoptosis and mitochondrial autophagy, increasing amyloid deposits in the brain. Long-term inflammatory stress pathway includes metabolic disorders, axis-microbe-intestines-brain, activation microglia and astrocytes and inflammatory cascade effect in the central nervous system [13]. Conducted pilot research on the volume of various types of memory and also a modern laboratory and clinical research by foreign scientists show a correlation between tooth loss and brain changes. In order to solve this problem should be conducted long-term basic research to determine whether tooth loss is a prognostic parameter.

## Conclusion

Young people with partial adentia have changed from the side of individual kinds of memory. After the extraction from 1 to 4 teeth, the volume of visual memory decreases from 2.6 % to 6.9 %; motor-auditory memory – from 0.6 % to 6.1 %; combined memory – from 1.8 % to 5.6 % and mechanical memory from 1.3 % to 5.6 % in comparison with the control group. A slight decrease in the volume of logical memory from 0.3 % to 3.4 %. The volume of auditory memory decreases from 0.7 % to 2.9 % in comparison with the control group of persons. The relationship between the group of extracted teeth and measures of the volume of different kinds of memory was not revealed.

To prevent changes from different kinds of memory it is necessary to recommend timely orthopedic and orthodontic treatment for young people with the aim of normalization the chewing process, improving blood circulation of the brain and increasing the activity of certain areas.

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