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Original article

The influence of vertical dimension of occlusion changes on the electroencephalograms of complete denture wearers

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ABSTRACT

Purpose: The present study was conducted to identify how changes in the vertical dimension of occlusion (VDO) affect the sensory perception and activity of the brain in complete denture wearers using an electroencephalogram (EEG).

Methods: Subjects were 21 individuals wearing complete dentures who regularly visited the Division of Prosthodontics at Tsurumi University Dental Hospital for checkups (12 males and 9 females, average age: 76.6). Based on their original dentures, two duplicate dentures with different VDO (−3 mm and +5 mm) were fabricated. EEG activity and occlusal force were measured before and after gum chewing with each denture in all subjects. Negative indicator scores for psychological conditions and stable neuronal activity ($D\alpha$) were calculated using EEG data. Statistical analysis was performed using the Wilcoxon test to compare changes in the sensory perception, activity of the brain, and occlusal force ($\alpha = 0.05$).

Results: After gum chewing with the +5-mm denture, a significant increase was observed in the negative indicator score ($p < 0.05$). No significant difference was found in the $D\alpha$ values before and after gum chewing with any of the dentures ($p > 0.05$). A significant decrease was observed in the occlusal force between the original denture and the −3-mm denture ($p < 0.05$).

Conclusion: Psychological condition and occlusal force were influenced by immediate changes in the VDO of the complete denture.

1. Introduction

Long-term use of a complete denture can result in jaw displacement due to abrasion of the artificial teeth. This can not only lead to aesthetic impairment but can also cause reduced masticatory performance and create abnormal stresses during chewing and biting. The vertical dimension of occlusion (VDO) affects the occlusal force, which may influence the stimulation of the central nervous system via the trigeminal nerve [1]. Also, previous studies have shown that occlusal disharmony caused by reduced masticatory

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Table 1 – Subjects' characteristics.

No.	Age	Gender	Type of denture base	Type of artificial teeth	Duration of denture use	Occlusal force (N)		
						Original	−3 mm	+5 mm
1	76	M	Resin	Hard resin	2 M	311	307	416
2	80	M	Metal	Hard resin	6 Y 7 M	224	230	273
3	77	F	Metal	Hard resin	6 Y 5 M	154	171	255
4	85	F	Resin	Hard resin	9 Y 7 M	119	102	427
5	76	M	Resin	Hard resin	1 Y 7 M	305	286	334
6	84	F	Metal	Metal	4 Y 11 M	368	225	249
7	84	M	Resin	Hard resin	2 M	299	191	135
8	83	F	Metal	Metal (upper) Hard resin (lower)	5 Y	174	161	216
9	86	F	Metal	Metal (upper) Hard resin (lower)	12 Y	177	116	144
10	70	M	Resin	Hard resin	2 M	299	134	253
11	76	F	Resin	Hard resin	1 Y 9 M	88	90	97
12	84	F	Resin	Hard resin	2 M	197	200	267
13	67	M	Resin	Hard resin	3 Y 4 M	480	467	348
14	83	M	Resin	Hard resin	2 M	221	106	332
15	69	F	Resin	Hard resin	7 Y	469	276	493
16	67	M	Resin	Hard resin	16 Y	230	357	667
17	76	M	Resin	Hard resin	5 M	338	227	193
18	67	M	Resin	Hard resin	7 Y	69	126	153
19	58	M	Resin	Hard resin	6 M	172	220	225
20	82	M	Resin	Hard resin	1 Y 3 M	465	358	671
21	66	F	Metal	Hard resin	4 M	208	121	242

performance produces chronic stress, which, if prolonged, can cause a decrease in learning ability [2]. Animal experiments have shown that changes in the VDO or presence of occlusal interference can cause changes in the serum corticosterone levels as well as an increase in the amount of dopamine released into the brain. Indeed, previous research has shown that occlusal interference and occlusal disharmony can cause stress on higher brain functions as well as on the whole body, and that occlusal disharmony can have a serious effect on the immune system and the nervous system [3].

Rhythmic masticatory muscle activity is coordinated by voluntary as well as reflexive control exerted by the upper central nervous system, including the motor area of the cerebral cortex and the hypothalamic-amygdala pathway, as well as by the reflex arc whose central connections are located in the midbrain, the pons, the medulla oblongata, and the upper cervical segments of the spinal cord [4]. In addition to receiving input from the upper central nervous system, the masticatory function processes peripheral sensory feedback from the teeth, jaws, masticatory muscles, and temporomandibular joints, whereas the central nervous system issues motor commands to muscles. The act of mastication is known to promote and maintain certain cognitive functions such as learning and memory [5]. Previous research has demonstrated that loss of the periodontal membrane due to the loss of teeth causes decreased stimulation to the hippocampus, which increases the risk of Alzheimer's disease [6]. According to a previous animal experiment, a partial loss of trigeminal mesencephalic neurons regulating periodontal mechanoreceptors occurs in guinea pigs that had had their teeth removed, which triggers remodeling of the central neural circuits that control masticatory muscle activity [7,8].

However, there is no existing evidence as to how changes in the VDO can affect the sensory perception and activity of the brain in complete denture wearers. In view of this, the present study was conducted to discover how changes in the VDO affect the sensory perception and activity of the brain as measured by an electroencephalogram (EEG) in patients with complete dentures. Occlusal force was also measured because it also has the potential to affect brain activity.

2. Materials and methods

2.1. *Subjects*

Subjects were 21 individuals wearing maxillary and mandibular complete dentures who regularly visited the Division of Prosthodontics at Tsurumi University Dental Hospital for checkups (12 males and 9 females, aged 58–86 years with the average age being 76.6 ± 7.8 years) (Table 1). There was wide variation in the duration of denture use, but all of the dentures had been maintained by prosthodontic specialists. Severe abrasion of the artificial teeth was never observed, and the VDO of all the dentures was appropriate. No subjects had histories of brain disease, such as cerebral infarction, or had been diagnosed with dementia, such as Alzheimer's disease. All subjects were fully informed of and consented to the research methods, which had been approved by the ethics committee of Tsurumi University School of Dental Medicine (approval number: 305, August 31, 2005).

2.2. *Fabrication of duplicate dentures*

To observe the brain response to the alteration of the vertical dimension of occlusion, the 2 types of duplicate dentures for