The relationship between masticatory efficiency and the state of dentition at patients with non rehabilitated partial lost of teeth

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Abstract

Factors believed to affect masticatory efficiency include loss of postcanine teeth, bite force, severity of malocclusion, occlusal contact area, body size and oral motor function.

The aim: to record if there is relationship between masticatory efficiency and the state of dentition at patients whose occlusion has never been rehabilitated.

Material: The study was performed in 22 patients who were missing over 50% of their functional dental units and never used any prosthetic appliances and in 15 healthy completely dentate controls.

Methods: The masticatory efficiency was measured using Optosil test for 20 and 80 cycles of chewing. The occlusal conditions were analyzed by means of the computerized T-Scan II System which registered the maximal force of pressure during the maximal occlusal contacts, the time which passed between the first contact and the maximal force of pressure and the occlusal platform area.

Results: It was observed a considerable difference in the integrity of the masticatory system between both groups. The force of pressure on the indicator, chewing platform area and the time from the first contact to the maximal force calculated in T-Scan II System differs significantly between both groups. The value of X_{50} for 20 and 80 cycles of chewing estimated in Optosil test were statistically significant only for 80 cycles of chewing.

Conclusion: The severe reduction of the number of functional dental units is caused of the impairment of chewing ability but prolongation of mastication could improve the comminution of hard food.

Key words: state of dentition, masticatory efficiency, Optosil test, T-Scan II System.

Introduction

The action of chewing food represents the initial step of its processing for digestion and absorption in the next part of digestive tract. The loss of teeth as a consequence of oral pathology, trauma or hereditary missing teeth results in the less or more advanced impairment of masticatory function. Although the masticatory system is easy to examine and a lot of different authors referred to the problem of chewing, there are still many aspects that need explanation to understand. Factors believed to affect masticatory efficiency include loss of postcanine teeth, bite force, severity of malocclusion, tactile sensitivity, occlusal contact area, body size and oral motor function [1-8]. The best predictor of masticatory performance without using complicated devices is the number of postcanine functional dental units, which is subsequently connected with the force of biting [9]. The main force of crushing food is localized in the posterior region of teeth while the centre of the occlusal contacts is located in the first molar regions (10). It was suggested that a larger maximal occlusal force was connected with a higher masticatory performance [11]. As well as the influence of occlusal contact area on chewing ability is not univocal, it could be found the contradictory results [7,12].

The aim of this investigation is to find out whether there is relationship between masticatory efficiency and the state of dentition at patients whose occlusion has never been rehabilitated.

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Received 22.03.2006 Accepted 30.03.2006

Table 1. **The number of teeth and functional dental units* in the examined and the control group. Means and ± SD are reported**

Dental characteristics	Examined group (n=22)		Control group (n=15)	
	Mean	SD	Mean	SD
Number of teeth	12	7	28	0
Functional dental units	4	3	14	0
Anterior functional dental units	3	2.5	6	0
Premolar functional dental units	0.6	0.8	4	0
Molar functional dental units	0.1	0.3	4	0

* The functional dental unit = a pair of any opposing teeth

Table 2. **Occlusal analysis recorded in T-Scan II System in the examined and the control group. Means and ± SD are reported**

T-Scan	Examined group (n=22)		Control group (n=15)		p
Parameters	Mean	SD	Mean	SD	
F	1799	2273	10041	7581	<0.001
CPA	45.9	54.8	252.9	112.8	<0.001
T	0.6	0.64	2.29	1.2	<0.001

F – the force of pressure on the indicator; CPA – chewing platform area – number of pixels multiplied by 1.6 mm^2 (the size of pixel); T – the time from the first contact of teeth to the maximal force (s)

Material and methods

The data was obtained in the group of 22 patients 39-61 years of age (average 51+/-7). They were 12 women and 10 men with the lack of teeth above 50% of so called functional dental units (a functional dental unit is a pair of opposite monomial teeth). The period they had lacked teeth was no shorter than one year. Their occlusion was never rehabilitated and they had not suffered from any diseases of the stomatognathic system. It can be said their health was in a good condition.

The study was also performed in 15 healthy completely dentate (that is 28 teeth, 14 dental functional units) volunteers as the controls. The group was composed of 9 women and 6 men corresponding the examined group with age (38-56, in average 49+/-4). They had not suffered from any diseases.

The people in both groups were selected on the basis of dental examination which included a comprehensive dental assessment, when the number of functional dental units was established, evaluation of masticatory efficiency and registration of occlusion in central position.

Masticatory efficiency:

The masticatory efficiency was measured using Optosil test for 20 and 80 cycles of chewing. Chewed test food was sieved through a stack of 10 sieves with aperture between 5.5 and 0.5 mm. The distribution of particle sizes by weight of the comminuted test food was described according to a Rosin-Rammler equation. The parameter X_{50} for 20 and 80 cycles of chewing by means the aperture of a theoretical sieve through which half of the weight could pass was calculated for a statistical analysis [12].

T-Scan analysis

The T-Scan allows quantification of occlusal contact data. The system consists of a sensor and a support, the handle assembly, the processing unit, software and a built in printer. When the patient closes firmly on the sensor, the resultant reduction in electric resistance is translated into an image on the screen. It allows its operator to record parameters such as bite length and the number, distribution, timing and relative force of teeth contacts [13,14]. We also calculated the size of chewing platform area of teeth during the pressure on the base of occlusal contact distribution.

The protocol study has been approved by the institutional Bioethic Commission and a written informed consent of each patient was obtained.

Statistical analysis

A descriptive analysis of each variable was made after calculating its frequency distribution and characteristic parameters. The statistical differences between the parameter values were tested by U Mann-Whitney test. The significance level was set at 0.05. The analysis was made using Statistica 6.0 Package.

Results

The *Tab. 1* shows the comparison between the examined and control groups with regard to the number of teeth and functional dental units. Functional dental units were subdivided by position in the dental arch: molar functional dental units (maximum 4), premolar functional dental units (maximum 4) and anterior functional dental units (maximum 6) [9]. On the base of this table we can observe a considerable difference in the integrity of the masticatory system between both groups. The average number of functional dental units was only four in the examined group and they were mainly anterior units.

The force of pressure on the indicator, chewing platform area and the time from the first contact to the maximal force calculated in T-Scan II System are presented in the *Tab. 2*.

Table 3. **Values of X_{50} (mm) established in Optosil test in the examined and the control group. Means and ± SD are reported**

Parameter	Examined group (n=22)		Control group (n=15)		p
	Mean	SD	Mean	SD	
X_{50}/20	5.27	0.31	5.08	0.31	n.s.
X_{50}/80	4.95	0.74	3.76	1.00	<0.001

X_{50} (mm) – the aperture of a theoretical sieve, through which half of the weight could pass; 20, 80 – the number of chewing strokes; n.s. – non significant

Table 4. **Correlations between estimated parameters for the whole participants**

Parameter	F	CPA	f.d.u.	X_{50}/ 20
F				
CPA	r=0.9530 **p<0.001**			
f.d.u.	r=0.6568 **p<0.001**	r=0.8138 **p<0.001**		
X_{50}(20)	r=-0.2344 **p=0.163**	r=-0.2622 **p=0.117**	r=-0.2816 **p=0.091**	
X_{50}(80)	r=-0.3920 **p=0.016**	r=-0.4983 **p=0.002**	r=-0.6308 **p<0.001**	r=0.7384 **p<0.001**

F – the force of pressure on the indicator (T-Scan II analysis) CPA – chewing platform area – number of pixels multiplied by 1.6 mm^2 (the size of pixel) (T-Scan II analysis); $T_{1/2}$ – the half time of gastric emptying in the ^{13}C octanoid acid breath test (min); f.d.u. – the number of functional dental units
X_{50}(20) – the aperture of a theoretical sieve through which half of the weight could pass for 20 strokes of chewing in Optosil test (mm)
X_{50}(80) – the aperture of a theoretical sieve through which half of the weight could pass for 80 strokes of chewing in Optosil test (mm)

Figure 1. **The value of X_{50} for 20 cycles of chewing estimated in Optosil test**

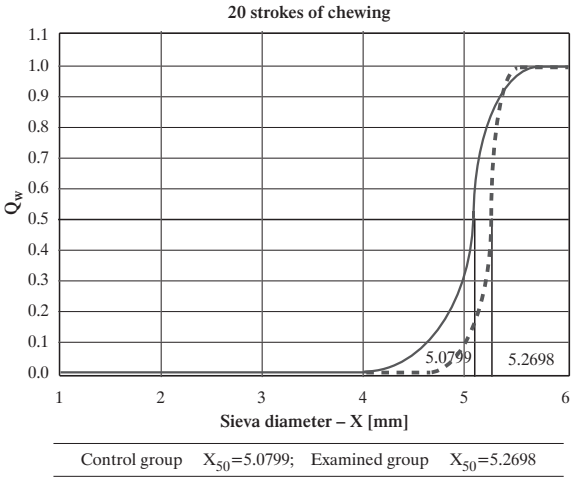
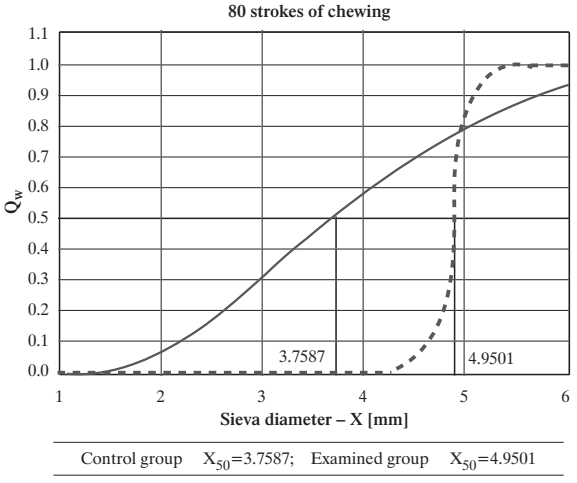


Figure 2. **The value of X_{50} for 80 cycles of chewing estimated in Optosil test**



Analyzing this data we can observe that all the differences are statistically significant.

The value of X_{50} for 20 and 80 cycles of chewing estimated in Optosil test as the measure of the ability of crushing food is presented in the *Tab. 3* and the *Fig. 1* and *2*. We have recorded the statistical significance between both groups only for 80 cycles of chewing.

It has also been found that there is a positive correlation between the force of pressure (r=0.6588, p=0.000), the chewing platform area (r=0.8138, p=0.000) and the number of functional dental units. The negative correlation has been recorded between the chewing platform area (r=-0.4983, p=0.002), the number of functional dental units (r=-0.6308, p=0.000) and the ability of comminution of solids for 80 cycles of chewing (*Tab. 4*).

Discussion

We formed the examined group selecting people whose occlusion had never been rehabilitated because prosthetic appliances could affect the masticatory patterns. Our patients had lack of teeth above 50%. As it was suggested the lack of teeth below 50% could be well compensated by existing in mouth teeth [15]. It was established that people with reduced number of posterior teeth report their chewing ability to be satisfactory as long as 20 well distributed teeth are present (3-4 occluding pairs preferably in a symmetrical position) [16,17]. One pair of occluding molars provides sufficient chewing ability [16]. Our patients from the examined group had evident problems with crashing food because of extremely shortened dental arches. A significant influence of the number of occlusal units on the masticatory performance was observed also by different investigators [18].

To establish the masticatory efficiency we chose the test based on chewing artificial food – silicon-rubber mass (Optosil). This test allowed the quantitative assessment of artificial food particles comminution as a function of the number of chewing strokes using standardised sieving method [19-21]. Therefore, we used just this test for the assessment of masticatory efficiency in our patients with suspected masticatory deficiency caused by

advanced teeth loss in comparison to the control group with good natural dental status.

As the result of lack of postcanine functional dental units the chewing platform area was considerably reduced. Moreover, the force of biting was reduced too. It was found during the estimation of occlusal central position in T-Scan II System registration. The necessary masticatory forces to prepare food in the mouth for digestion are 6 kg for each tooth during mastication, and the degree of force may vary according to the physical features of food [22]. The maximal forces which were determined using gnathodynamometer were established as over 90 kg in back segments and over 60 kg in the front segment but it was also recorded that there was a certain difference between the intraoral forces during mastication and measured maximum intraoral forces [23]. Evident diminishing of chewing platform area and force of crushing hard particles as the result of lost of teeth are caused the impairment of chewing ability.

It was suggested that impossibility of comminution of hard food was improved by prolongation of chewing [24-26]. Although, the mechanism of compensation the deficiency of chewing was not became clear but on the base of our investigation it was evident that short chewing of food did not cause the essential difference in crushing particles in the examined group independently of the state of dentition. Only prolongation of chewing improved the comminution of hard particles [24].

Our results showed that there was a close relationship between the number of teeth, the force of preassure on the indicator, the chewing platform area of teeth which takes part in mastication and the ability of comminution of food for 80 cycles of chewing by means during long chewing. Comparative results, carried out in Netherlands, recorded that chewing performance as measured with chewing tests, declined lineary with decrease of chewing platform area and extreme shortened dental arches comprising 0-2 occluding premolars resulted in severe impairment of chewing ability [16].

Conclusion

The severe reduction of the number of functional dental units is caused of the impairment of chewing ability but prolongation of mastication could improve the comminution of hard food.

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