

# Evaluation of the Masticatory Efficiency at the Patients with New Complete Dentures

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## Abstract

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**BACKGROUND:** There are a lot of factors influencing the efficiency of mastication; therefore there are also a lot of methods for testing this efficiency.

**OBJECTIVE:** The study aimed to test the efficiency of mastication and evaluate it in the function of time, based on previous experience with the complete dentures.

**METHODS:** A total of 88 patients (42 female, 46 male, mean age 52.2, SD = 5.76), complete dentures wearers, participated in this study. Masticatory functions were investigated by using the method of electromyography (EMG), analyzing electromyomasticatiogram. For testing the masticator efficiency, the further parameters of the masticatiogram were used: duration of the Standard Masticatory Task (SMT) (t), number of the masticatory cycles within the masticator arch (F) and maximal amplitude within the masticatory arch (F). All data were statistically analysed by using standard software package BMDP (bio-medical Statistical package). Parametric data have been tested using One Way Repeated Measurement of ANOVA test.

**RESULTS:** The changes of the relation A/t are evident in different time intervals in both measured sides: F-DS-time of the measurement = 34.86, P = 0.0000; F-NDS-time of the measurement = 26.1, P = 0.0000. There are also differences of the masticatory index A/t between sexes in both, dominant and non-dominant side: F-DS-gender = 237.05, P = 0.0000; F-NDS-gender = 12.90, P = 0.004. Masticatory index (A/F) varies in time, from first to the sixth measurement in both sides: F-DS-time of the measurement = 32.36, P = 0.0000; F-NDS-time of the measurement = 30.53, P = 0.0000. The interaction of the time and gender was also important: F-DS-interaction = 6.95, P = 0.0000; F-NDS-interaction = 14.9, P = 0.0000.

**CONCLUSION:** Masticator indexes are A/F, and A/t are a very important indicator of the masticatory efficiency and the level of the functional adaptation on complete dentures. Both masticator indexes show the same dynamics (reaching the stationary condition after the 15th week after getting new dentures). After the observing period, all examinee express the same degree of masticator efficiency known as functional adaptation. Patients with previous experience with complete dentures reach faster the stationary condition, compared with those non-experienced.

## Introduction

During the masticating process, the food is crushed and ground by placing between the teeth, by the cheek and tongue. During the chewing process, the food is reduced in small size by 10-40 masticator cycles, forming a bolus which can be swallowed easier [1] [2] [3].

Masticatory efficiency is defined as the number of strokes needed to achieve a certain particle size reduction [4].

There are a lot of factors influencing the efficiency of mastication: teeth condition, the number of antagonists left, the size of the chewing surfaces of the teeth, chewing force, masticatory movements and masticatory tempo, factors pertaining with a prosthetic work, food consistency and regular distribution of the bolus during mastication. In the natural dentition bolus size and its preparation are adapted to swallowing capacity [5] [6].

Nagasawa T et al., [7] showed that reduced masticatory efficiency could be associated with a relation of small contacts between the teeth and

reduced activity of masseter muscle and temporalis muscle. A lot of researchers showed that complete denture wearers, compensate reduced efficiency of mastication with a larger amount of bolus and not with extended chewing [3] [6] [8] [9].

The problems associated to the relation between the masticatory efficiency and tests of the food grinding, evaluated by patients, are shown from a lot of authors as Agerberg and Carlsson [10], Gunne J. et al., [11], Carlsson and Ericson [12].

After getting new dentures, geriatric patients have low indexes of the masticatory efficiency.

After special treatments (like dentures over the implants), the efficiency of mastication increases [13] [14] [15]. The period of adaptation to new complete dentures is longer in geriatric patients than it is in other patients [16].

A lot of methods are in use for investigating the masticatory efficiency as Fluctuation of the food particles, tested by the system of nets (strainers) with different diameters; Photocolorimetry; Electromyography; Ultrasonography [17].

The study aimed to evaluate the efficiency of mastication at different time periods, based on patient's previous experience with complete dentures; also, to indicate the period needed for adaptation to the new complete dentures.

## Material and Methods

A total of 88 patients (42 female, 46 male, mean age 52.2, SD = 5.76), complete dentures wearers, participated in this study. The research was carried out at the University of Prishtina, Dental School, Department of Prosthetic Dentistry. The research has been accepted and approved by the Institutional Ethics Committee (Medical Faculty, School of Dentistry, University of Prishtina). All participants were first clinically examined, and after they were informed about investigation procedures, they signed a written consent.

The main criteria for including in this study were: patients with complete dentures, eugnathic jaw relation and uniform reduction of the alveolar ridge. Excluding criteria were: age over 70 years, jaw relation anomalies in the horizontal and sagittal plane, dysfunctions of the masticatory system and high rate of the resorption of the alveolar ridge (negative ridge).

All examinees were selected into two experimental groups: Group 1 was composed of new complete denture wearers, and Group 2 was composed of the patients who were already complete denture wearers.

All examinees were followed for 6 months.

During this period, the result of the prosthetic therapy was expected after insertion of new dentures. During the observation period, each examinee was tested six times by the same examiner, to reduce inter-observer error. The first test was done one week after inserting new dentures, following other tests every 5<sup>th</sup> week.

In this study, masticatory functions were investigated by using the method of electromyography (EMG), analysing electromyomasticatiogram. This method enables: direct analyze of bioelectric activity of the masticatory muscles *in vivo*, during realization of SMT; analyze of the synchronized action of homologous pair of the muscles; expression of the regularity of masticator scheme; expression of the dynamics of the masticatory cycle and its determinants (duration, frequency and amplitude of the masticatory cycle) and finally enables documentation of the obtained results. Standard masticatory task (SMT) depends on the type of food (hard, soft and impulsive food)

A different kind of food can be used as a test food (natural and artificial) [18]. For this research, a peanut was used as a test food (hard food), as this food enables analyse of masticatory efficiency without initial contacts of the teeth and in the same time affects the changing of the load level of the neuromuscular control of the mastication. Peanuts are non-synthetic, relatively hard, popular, swallowable, and represent test food in previous studies of mastication as well [13].

Masticatory efficiency test consists in chewing the food of constant quality and quantity. Patients were suggested to chew spontaneously from one side to another.

For testing the masticatory efficiency, the further parameters of the masticatiogram were used: duration of the SMT (t), number of the masticatory cycles within the masticatory arch (F) and maximal amplitude within the masticatory arch (F).

For this purpose, two masticatory indexes were used:

Masticatory index: muscular activity in relation with time (A/t) presents the relation between the maximal amplitude of bioelectric oscillations of the tested muscle (A) (masseter muscle and temporalis muscle) and duration (t) of the standard masticatory task in electromasticatiogram. This relation is expressed by nV/sec.

Masticatory index: muscular frequency activity (A/F) presents the relation between the maximal amplitude of bioelectric oscillations of the tested muscle (A) and frequency of the masticatory cycles (F) during registering of the standard masticatory task in electromasticatiogram. This relation is expressed by nV/Hz.

Masticatory indexes strictly define the standard masticatory task. The duration of the

standard masticatory task (t) is determined by appearing of deflection in the electromasticiogram.

EMG registered SMT as an electromasticiogram on a paper of Dynograph. (EMG-Dynograph R-511 A) (Figure 1).



Figure 1: EMG-Dynograph R-511 A

During the measurements, the side of the jaw that showed higher masticatory force was named as a dominant side (DS) while the opposite side was named as a non-dominant side (NDS).

All data were statistically analysed using standard software package BMDP (bio-medical Statistical package), dedicated to research in the biomedical sciences. This package includes all methods of statistical procedures, (Dixon, 62.). Parametric data have been tested using One Way Repeated Measurement of ANOVA test.

## Results

Of 88 patients, 45 belong to the new complete denture wearers while 43 were experienced wearers of complete dentures (Table 1).

Table 1: Comparison of gender, age and non-experienced/experienced group

	Gender		Non-experienced/experienced group with complete dentures	
	Female	Male	Non-experienced	Experienced
N	42	46	45	43
X	54.6	55.7	52.7	57.8
DS	5.4	6.1	5.7	4.1
X max	66	68	65	68
X min	42	44	42	49

*Dynamics of the index of masticatory efficiency:* Masticatory index was analysed according to the duration: using the index of muscular activity in time (A/t) and according to the frequency, using indexes of muscular frequency during masticator cycles in SMT (A/F).

Dynamics of the masticatory index (A/t) is presented in Table 2.

Table 2: The values of the masticatory index during the realisation of SMT in 6 time intervals, in DS and NDS, in both sexes with and without experience with complete dentures

Measurement	Gender				Experience				Total	
	F		M		E		NE		DS	NDS
	DS	NDS	DS	NDS	DS	NDS	DS	NDS	DS	NDS
N	42	42	46	46	45	45	43	43	88	88
1x	12.9	10.8	12.4	14.8	13.6	14.6	11.9	11.2	12.7	12.9
DS	0.3	0.74	0.83	0.76	0.78	0.48	0.61	0.46	0.53	0.6
2x	25.3	19.5	16.3	23.1	20.9	22.1	20.3	20.7	20.6	21.4
DS	0.62	0.81	0.74	1.16	0.98	1.14	0.95	0.68	0.74	0.69
3x	33.9	29.6	19.5	18.4	27.9	24.9	24.7	22.5	26.3	23.7
DS	1.89	1.74	0.77	0.73	1.85	1.65	1.65	1.40	1.25	1.1
4x	24.2	25.8	20.8	21.0	23.0	25.1	21.9	21.4	22.5	23.5
DS	0.8	1.55	0.90	1.0	0.92	1.45	0.90	1.17	0.64	0.94
5x	28.4	20.7	20.0	220.1	24.8	22.1	23.2	18.7	24.0	20.4
DS	1.0	1.14	0.89	0.78	1.225	1.0	0.99	0.80	0.80	0.68
6x	33.6	26.8	18.6	22.1	25.8	26.1	25.8	22.5	25.8	24.3
DS	1.11	1.31	0.87	1.10	1.58	1.43	1.36	0.93	1.0	0.88

The changes of the relation A/t are evident in different time intervals in both measured sides: F-DS-time of the measurement = 34.86, P = 0.0000; F-NDS-time of the measurement = 26.1, P = 0.0000.

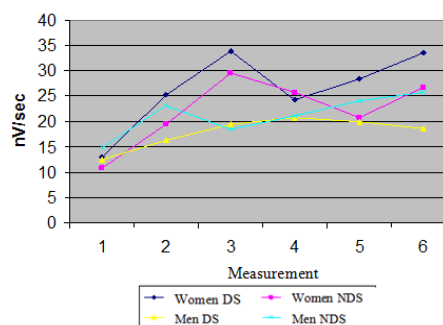


Figure 2: MI A/t during the realisation of SMT according to gender

In DS is evident increasing from 13 nV/sec. In the first two months after getting new dentures, to the stationary value of approximately 24 nV/sec. In the fourth month.

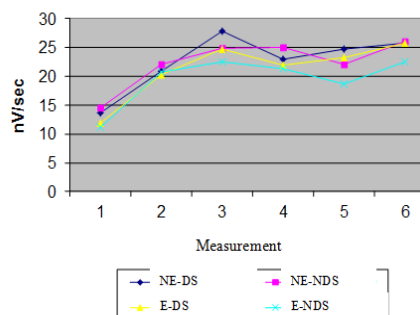


Figure 3: MI A/t during the realisation of SMT according to the experience with complete dentures

In NDS the stationary condition is reached in the second measurement 22 nV/sec.

There are also differences of the masticatory index A/t between sexes in both, dominant and non-dominant side: F-DS-gender = 237.05, P = 0.0000; F-NDS-gender = 12.90, P = 0.004.

In the DS the values of the masticatory index

A/t are higher in women then in man. Interaction of the gender and time shows also significant differences: F-DS-interaction = 18.52, P = 0.0000; F-NDS-interaction = 14.14, P = 0.000.

In the DS there is no significance of the index values F-DS-experience = 3.75, P = 0.0535 while in the NDS there is a significance of the index values: F-NDS-experience = 20.12, P = 0.0000.

In NDS the values of the masticatory index are higher in patients with no experience with complete dentures then in those who have some experience.

The dynamics of the masticatory index A/F is presented in Table 3.

**Table 3: The values of the masticatory index (A/F) during the realisation of SMT in certain intervals, in DS and NDS, in both sexes with and without experience with complete dentures**

Measurement	Gender				Experience				Total	
	F		M		E		NE		DS	NDS
	DS	NDS	DS	NDS	DS	NDS	DS	NDS	DS	NDS
N	42	42	46	46	45	45	43	43	88	88
1x	9.8	7.7	8.3	10.2	9.2	9.9	8.8	8.0	9.0	8.9
DS	0.3	0.4	0.5	0.4	0.5	0.4	0.4	0.4	0.3	0.3
2x	16.9	14.1	10.7	15.1	13.5	15.0	13.9	14.2	13.7	14.6
DS	0.5	0.7	0.6	0.6	0.7	0.7	0.7	0.7	0.5	0.5
3x	24.4	20.5	14.5	12.2	20.2	16.3	18.3	15.9	17.0	17.3
DS	1.1	1.2	1.8	0.4	2.0	1.1	1.2	1.1	1.2	0.8
4x	18.6	18.6	15.5	16.1	17.4	18.7	18.7	16.5	17.0	17.3
DS	0.8	1.2	0.7	0.6	0.9	0.7	0.7	0.6	0.5	0.5
5x	21.4	16.0	15.5	15.9	18.6	16.8	18.0	14.9	18.3	15.9
DS	0.7	0.8	0.7	0.6	0.9	0.7	0.7	0.6	0.6	0.5
6x	22.6	19.9	14.1	14.9	18.0	18.2	18.3	16.4	18.2	17.3
DS	0.6	0.9	0.6	0.7	0.9	0.9	0.9	0.7	0.6	0.6

As it is noticed in the table, masticatory index (A/F) varies in time, from first to the sixth measurement in both sides: F-DS-time of the measurement = 32.36, P = 0.0000; F-NDS-time of the measurement = 30.53, P = 0.0000.

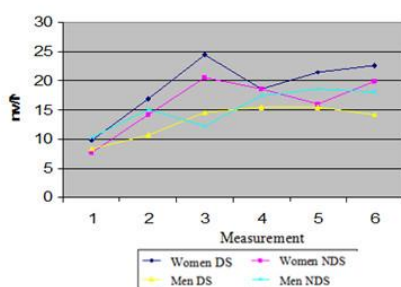


Figure 4: MI A/F during the realisation of SMT according to gender

The stationary condition is reached after the third measurement, in DS from 9nV/Hz to 19nV/Hz. In the NDS this condition is reached on the third measurement.

A/F index is also different in different gender, on both measured sides. The interaction of the time and gender was also important: F-DS-interaction = 6.95, P = 0.0000; F-NDS-interaction = 14.9, P = 0.0000.

In the DS there is no sign of the A/F index as

far as the previous experience in complete dentures concerned: F-AD-experience = 0.86, P = 0.3530 while in the NDS there is a significance: F-AJD-experience = 11.88, P = 0.0006.

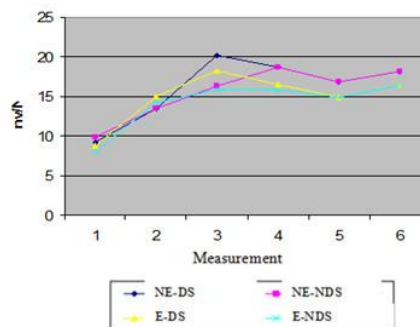


Figure 5: MI A/F during the realisation of SMT according to the experience with complete dentures

The examinees with no previous experience with complete dentures have had higher average values of the masticatory index in the NDS then examinees with some experience with complete dentures.

## Discussion

The main task of this research was an investigation of the masticatory efficiency in patients with complete dentures. Muscular activity is improved by getting new dentures; however, a muscle adaptation to the new prosthesis is still needed [19].

Goiato MC et al., [17] concluded that after getting new dentures, the muscular balance of the masticatory system happens, by neuromuscular reprogramming.

The first parameter that prescribes the adaptation of the examinees with the new dentures is time needed for realisation of SMT. On average, from initial values of 29 seconds, this parameter decreases continuously reaching the time of 21 seconds finally. The variation of these values is relatively small what means that in general, the group is homogenous about measured time. The stationary condition is reached relatively fast (after 10 weeks from getting new dentures. According to Goiato, after getting new complete dentures, lowered muscular capacity and ability reduced [20].

Initial values of 29 seconds were same for both sexes decreasing in the end at 17 sec. In women and 24 sec. In man. The reason for this can be that women react more intensively in the beginning while a man needs more time for the functional adaptation.

In the DS the values of the masticatory index, A/t is higher in women than in man. In NDS the values

of masticator index are higher in patients with no experience with complete dentures than in those who have some experience.

In the DS there is no significance of the A/F index as far as the previous experience in complete dentures concerned. The examinees with no previous experience with complete dentures have had higher average values of the masticatory index in the NDS than examinees with some experience with complete dentures.

The examinees non experienced on complete dentures, in the beginning, have had a shorter duration of SMT comparing to the examinees experienced on complete dentures, but in the end, the values of the final duration of SMT were the same (NE and E group). This can be explained by neurophysiologic models of mastication since they provide a lot of information on the functioning of the masticatory organ in human [21].

Masticatory index A/t defines the bioelectric activity of the tested muscles (Masseter muscle and Temporalis muscle) in time. It was expected that higher values of the amplitude would be followed by shorter duration of the SMT and vice versa. In the same way the second masticatory index A/F too, brings in a connection the amplitude and the frequency of the masticatory cycles during the realisation of the SMT. Efficient SMT can be performed in a shorter time with a smaller number of masticatory cycles but with a higher maximal amplitude of the masticatory arch. According to Kijak E et al. [21], the consistency of the food products had a decisive impact on the frequency of mastication and the number of cycles necessary to grind the food.

In this investigation, the SMT was used as an index for measuring the masticatory efficiency while other authors have used other indexes. Ferreira et al. used MSI (masticatory stability index) as an efficient method to measure the stability of the masticatory cycles [22].

The method of analysing of the masticatiogram, with EMG is objective since the evaluation of the masticatory index is not taken due to the referent values as it is done in the classical investigations.

In conclusion, masticatory indexes, A/F and A/t are a very important indicator of the masticatory efficiency and the level of the functional adaptation on complete dentures. Both masticatory indexes show the same dynamics (getting in the stationary condition after the 15<sup>th</sup> week after getting new dentures). After the observing period, all examinees express the same degree of masticatory efficiency known as ideal or functional adaptation. Patients with previous experience with complete dentures reach faster the stationary condition, compared with those non-experienced.

Based on the results of the investigation, it is

concluded that after getting new dentures, the stationary condition is reached after about 10 weeks. This fact can help doctors and patients for better understanding the period of adaptation and easier facing with new dentures.

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