PROTOCOL FOR THE STUDY OF MASTICATORY FUNCTION

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ABSTRACT

The present paper suggests a protocol for the study of masticatory function of a control group of 14 patients with clinically healthy dentition using natural food sample, consisting of 5g of Bulgarian roasted peanuts. Among evaluation criteria applied have been the study time (in seconds), the number of masticatory movements and the triggering of swallow reflex in each patient. The degree of fragmentation has been evaluated based on the particles' size and size distribution by sieve analysis. The optimal mass of chewed food for each fraction has been determined by statistical analysis. The statistically significant results obtained for the particle size, size distribution and average size allow to be used as standards in clinical practice for evaluation and comparative analysis of the masticatory function of patients with healthy as well as prosthetic dentition.

KEYWORDS: study of masticatory function, sieve analysis, particle size, size distribution.

INTRODUCTION

The breach of occlusal-articulation relationships as a result of impaired integrity of dental rows or incomplete prosthetic treatment is often associated with the development of functional pathology of the masticatory apparatus¹,²,⁵, possible impairment of other adjacent structures or systems and their neurogenic hormonal regulation, which in turn reflects the quality of life.³,⁴ Edentulism (partial or complete) is typically linked to age, education, social background, financial status and smoking.⁶
Functional methods for the study of the masticatory apparatus involve gnathodynamometric, static and functional tests. Gnathodynamometry provides a quantitative value for the endurance of a tooth. Whereas static methods rely on numerical coefficients of individual teeth and are more indicative of the functionality of the masticatory apparatus. On the other hand, most information can be collected from functional methods - chewed samples, electromyography, refractory oscillographs, T-scan, etc.

Since functional measurements cover the entire complex of morphological structures and physiological processes in the oro-facial entirety, most accurate data can indeed be obtained from them when they are conducted in as close to natural conditions. Our focus was rather directed onto the study of masticatory function with the ever-increasing trend towards healthy eating and the related consumption of raw, high-fibre, "green" foods.

**Objective**
To create a protocol for the study and quantification of masticatory function of patients with healthy as well as prosthetic dentition.

**MATERIALS AND METHODS**

**Materials**
The target audience of the study were 90 patients, of whom 57 women and 33 men (average age 20 years), who randomly visited our dental practice over a period of one year. Following an extra- and intraoral examination for the purpose of the pilot study, 14 people have been approved, aged 22 - 25 years old, healthy, with intact dentition, without orthodontic anomalies or any previous orthodontic treatment, with healthy periodontium. Three patients have exhibited small occlusal fillings (up to 2 fillings) which does not significantly affect the masticatory function.

Participants' involvement in the study was voluntary and following informed consent.
The natural food sample used was a 5-gram package of Bulgarian peanut ("Kalina" brand), pre-cooked in hot air of 60°C for 24 hours to a residual moisture of 2.04%.

**Methods**
- **The Instructions to patients on how to use the natural food sample were as follows**
  1. Rinse your oral cavity with a solution of sodium hydrogen carbonate to reduce adhesion of chewed particles to the oral mucosa.
2. Pour the contents of the packaged food sample directly into the cavum oris to avoid contact with hands and then start the process of chewing.

3. Then place the food sample chewed (turned bolus) into a tared paper cup.

4. Rinse the mouth cavity with a small amount of water (2*10 ml) to remove particles stuck to the mucosa and the occlusal and interdental spaces, then add the residual amount to the contents of the cup.

The duration of mastication has been determined in three different ways: elapsed time in seconds (using a Stopwatch), number of chewing movements and the triggering of swallow reflex (as per Gelman's masticatory powers, Christensen's masticatory performance (efficiency) and Rubinov's masticatory ability).

- Determining particles' size of the natural food sample following mastication and their size distribution.

The process of determination has been carried out using a sieve analysis. A set of sieves with dimensions of sieve opening sizes: 200 μm; 315 μm; 500 μm; 630 μm; 1,00 mm; 2,00 mm, in a descending order. (Fig.1)

![Fig.1 Sieve analysis](image)

**The test process:** The test material obtained is placed on the top sieve and the bolus is washed in 1200ml of water. The collection tray placed at the base of the set of sieves gathers the washed liquid and the quantity of test material with particles sized < 200 μm. The washed particles is then being dried at dry heat as the entire set of sieves is placed in a desiccator at a temperature of 60°C for 20 minutes, and afterwards arranged onto the sieve shaker. The
amplitude of the shaker movement is 1mm, the cycle is 10 seconds, for a duration of 2 minutes.

Fig. 2 Desiccator (Drying cabinet)

Sieves are placed back in the desiccator, and the drying process continues for further 4 hours at 60°C.

The amount of particles retained on the surface of each sieve is established by a digital scale accurate to 0.01 g. The particles' size between two consecutive sieves corresponds to the average size obtained from the size of the two sieves.

- The statistical evaluation has been carried out using a Software package for epidemiological and clinical data analysis SPSS for Windows, Version 16.00 (15/11/2007).

RESULTS
The pilot study has revealed that women more frequently than men visit their dental doctor for a regular checkup. The 14 volunteers selected were respectively 6 men and 8 women. For a more precise duration of mastication 3 indicators have been considered for each participant: time measured by a stopwatch, number of chewing cycles and the triggering of swallow reflex. The results obtained show that the sample food has been chewed at the single consumption. The shortest time to trigger a swallow reflex has been 31.02 seconds, and the longest - 48.01 seconds. The greatest number of masticatory movements required to chew the food has been 70, and the fewest - 40; swallow reflex has respectively been triggered in an average of 40.08 seconds for 61 chewing movements.
The results obtained from sieve analysis are displayed in Table 1 and Figure 1.

**Table 1: Particle-size distribution of natural food sample following chewing**

<table>
<thead>
<tr>
<th>Sieve Number</th>
<th>Diameter (mm)</th>
<th>Mass of Chewed Food Retained on Each Sieve (g)</th>
<th>Percent pertained (%)</th>
<th>Percent Finer (%)</th>
<th>D₁₀</th>
<th>D₃₀</th>
<th>D₆₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>2.0 mm</td>
<td>5.07</td>
<td>7.24</td>
<td>92.76</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>1.0 mm</td>
<td>7.42</td>
<td>10.60</td>
<td>82.16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>630 µm</td>
<td>6.41</td>
<td>9.16</td>
<td>73.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>500 µm</td>
<td>5.01</td>
<td>7.16</td>
<td>65.85</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>315 µm</td>
<td>5.79</td>
<td>8.27</td>
<td>57.58</td>
<td></td>
<td>0.37</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>200 µm</td>
<td>3.25</td>
<td>4.64</td>
<td>52.94</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAN</td>
<td>37.06</td>
<td>52.94</td>
<td>0.00</td>
<td>0.04</td>
<td>0.115</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Table data indicate that different amounts of food chewed pass through each sieve: for the larger sieve openings a functionally healthy dentition produces less amount while the most amount passes through a sieve with 200 µm opening.

The Table data has been reflected in Chart 1.

**Fig. 1. Particle-size distribution of natural food sample following chewing**

The semilogarithmic dependence of particle-size distribution allows for a graphic representation of the percentage of particles' size for each fraction. The highest percentage D₆₀ are particles of an average diameter of 0.37mm, 30% are particles having a diameter of 0.115mm, and 10% are particles with a size of 0.04mm. The results manifest a relatively narrow range (0.04 - 0.37mm) of particle-size distribution.
DISCUSSION
The present paper introduces a protocol for the study of masticatory function using food sample from 5-gram packages of Bulgarian roasted peanuts variety ("Kalina" brand). The method allows to establish limit values of the duration of the masticatory process as well as the number of chewing movements. The particle-size distribution analysis suggests the optimal particles' size of the food chewed, the optimal time and number of chewing movements.

The protocol proposed has made it possible to determine the extent of mastication of natural test food and serves for evaluation of the functionality of a dentition.

CONCLUSIONS
The following diagram can be suggested based on the experimental study of masticatory function:

![Diagram 1. A protocol for the study of masticatory function](image-url)
The protocol for the study of masticatory function proposed in this paper is rather accessible in terms of materials used and being inexpensive it can be widely used in ambulatory practice for the evaluation of masticatory function of patients with different types of dental prosthesis. Based on the experimental study performed the following optimal parameters have been concluded regarding the masticatory process in patients with intact dentition:

**Table 2: Optimal parameters of the masticatory function in patients with healthy dentition**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of chewing before triggering of swallow reflex</td>
<td>40.08 seconds</td>
</tr>
<tr>
<td>Number of chewing movements before triggering of swallow reflex</td>
<td>61 times</td>
</tr>
<tr>
<td>Average size of particles as a result of chewing before triggering of swallow reflex</td>
<td>0.265 mm</td>
</tr>
</tbody>
</table>

The amount of food chewed for each fraction can be compared with the optimal amount obtained from clinically healthy dentition and can serve for the evaluation of prosthesis constructions.

The data indicate that even for a selected control group of patients with healthy masticatory apparatus the study of masticatory function involves a number of considerations associated with the stereotype of chewing. The largest mass of fraction produced by healthy dentition reveals most finely distributed particles (below 200 μm).

**REFERENCES**