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HISTORICAL REVIEW OF GNATHODYNAMOMETRIC METHODS USED FOR THE ASSESSMENT OF MASTICATORY FUNCTION

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ABSTRACT

Gnathodynamometric methods prove to be the oldest means available of obtaining an objective quantitative evaluation of masticatory efficiency. On the basis of data collected using these methods static methods were later introduced and in early 20th century functional dynamic methods were first applied. Referring to dental literature records, the authors' objective was to provide a review of available historical facts about the origin, development and application of gnathodynamometers in the study of masticatory function.

Keywords: gnathodynamometer, study of masticatory force, bite force, masticatory force

Gnathodynamometric methods appear to be historically the oldest of all methods for the study of masticatory function [1]. They equip the dental clinician with information about the strength of the muscles of mastication, periodontal reactivity as well as the functional and physiological balance of teeth. The data can be obtained using a gnathodynamometer, a instrument for measuring the muscles which elevate or depress the mandible during mastication [2].

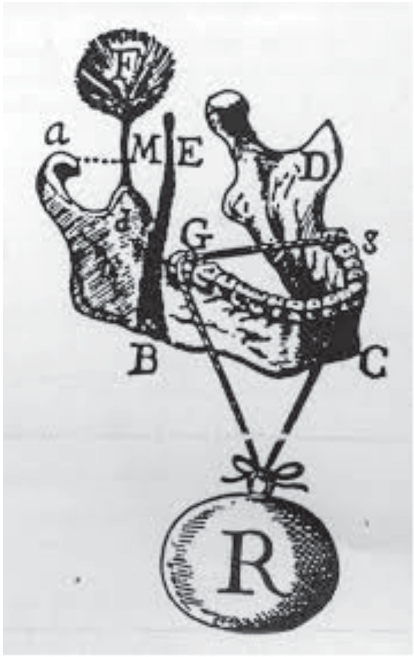
The aim of the present review is to explore the origin, development and application of gnathodynamometers in the study of masticatory function.

MATERIALS AND METHODS

For the purposes of retrieving literature data a thorough analysis was initially carried out on currently available relevant literature. Search Method: Over the period March - October 2015 the search was performed in stages based on the electronic data bases Pub-Med, Science-Direct, Scopus in English, German and Russian. Parallel to that search a manual literature search was implemented for paper sources in Bulgarian, English, German and Russian at the University Libraries in Varna and Sofia. The following key words were used for the purpose: gnathodynamometer, study of masticatory force, bite force, masticatory force.

As far back as 1681 Borelli, a professor of anatomy in Rome first estimated the force of the muscles of mastication [1]. The scientist's method of procedure was to transversely pass a loop of cord over the molar teeth of the open mandible and under the patient's chin, onto which he then attached various weights (Figure 1).

Fig. 1. Borelli's gnathodynamometer [3]



The best-known name in connection with gnathodynamometers is that of G. V. Black, who worked at the subject as far back as 1893. The chapter, „The Force in Mastication " in his "Operative Dental Surgery" contains a concise, although by no means exhaustive, account of the subject. In 1900 Black constructed the first intraoral device for measuring the interplay of forces between the upper and lower dentition. He performed this study not only on natural but also on plastic teeth of plate dentures. It was established that the latter endured 1/4 to 1/3 of the pressure habitually exerted by natural teeth. Later Black created an instrument which he called a phagodynamometer, consisting of two rugged plates, between which he placed the test food, to estimate the force required for crushing.

Much interest caused Haber's book entitled "Die Aufgaben der Kaudruckmessung und der Zahndruck-Priifing" which comprised all known research on the subject until that time [4].

Gnathodynamometers may be divided into three classes according to the method of their construction:-

1. Those which act directly on to the jaw or by means

of a simple lever (Hebelkonstruktion),

2. Those which contain a spring (Federkonstruktion),

3. Those which combine lever and spring, or lever, spring and manometer (Kombinietekonstruktion).

A fourth group is described in which splints are placed upon the teeth and a steel stud impinges upon lead (Kugelkonstruktion).

GROUP I is represented by Borelli's gnathodynamometer, which is a loop of cord passed over the open mandible with various weights from 60 kg to 200 kg attached to it. According to the weight which could be raised by closing the jaw, he estimated the force of the muscles of mastication. Haber gave a translation in German of the original Italian in which the weight was defined between 90-242 kg, suggesting that the neck muscles came into play in addition to the muscles of mastication.

A hundred years later, Sauer used the same method by placing a flat strip of iron across the molar teeth, of sufficient length to project beyond the corners of the mouth. A hole was bored, through which a cord was passed and secured. The end of the cords was attached to a weight standing on the floor and it was so arranged that with the mouth open the cord was quite tense. By elevation of the jaw, the weight, if not too heavy, was lifted and by means of suitable additions or subtractions the exact weight was found which could be raised and the force of the muscles accordingly estimated.

In 1911 Eckermann assumed that a firmly closed jaw needed the same force to overcome the muscular effort as was exerted to achieve contact between the occlusal surfaces of the teeth. The apparatus he created, entirely made of steel, was quite simple and shaped like a pair of pliers. The jaws of the pliers, covered with a softer material on the outer side, were gripped between the teeth. Based on his research he prepared a formula to make the measurement easier. This method of estimation was untrustworthy since although it might be possible to build a model which would give results according to Eckermann's formula, the individual characteristics of the patient, their speicific bite, root canals and so on change the values of the proposed formula, thus rendering the results unreliable.

In 1920 Gysi introduced a new test food (spinach or cereals) and observed that in mastication there was "a working side" and "a balancing side" of the jaw. He created a wooden model representing the muscles of the body and this proved that in measuring the force exerted by the muscles of mastication, the muscles of both sides should be included.

GROUP II was represented by gnathodynamometers which operate by means of a spring.

Dr. Black used an instrument consisting of two bars, one of which is rigid, the other a strong flat spring. He made a trial of the force of the teeth among the students in his classes. In the tabulation of the results of 1,000 persons the average force was 64 kg. on the molar teeth, and considerably less on premolars and incisors. Black was the first to recognize the importance of the periodontium and the receptors located in it.

Head criticized Black for testing only the forces transmitted vertically, arising from the vertical movement of the mandible, and not all the forces involved in a natural mastication process. He did not take into consideration the role of periodontium. Morelli compensated that by using Collin's dynamometer to measure the forces between the pair of antagonists' teeth and up to the moment the periodontium became tender. The time and force multiplied together gave a Pressure Constant figure. Observing the area of the root surfaces and the pressure constant, he found out that the tolerance of the periodontium is proportional to the area of the root surface. Morella and later Vesky explained the mechanism thanks to which the periodontium endured such pressure by comparing it to a hydraulic system.

Kristiansen (1925, Copenhagen) utilized the principle of the parallel pliers. The jaws of the pliers were separated in the condition of rest. By compression of the biting plates the spiral spring was stretched and the amount of force used was registered.

Haber devoted a considerable amount of time and energy to popularizing the use of the gnathodynamometer both for the specialist and for the general practitioner. He constructed three patterns of gnathodynamometers. Two of them belong to the group of gnathodynamometers which operate by means of a Spring (Figures 2 and 3).

Fig. 2. Haber's gnathodynamometer in box, together with „biting plate" for estimating the pressure of single teeth [4].

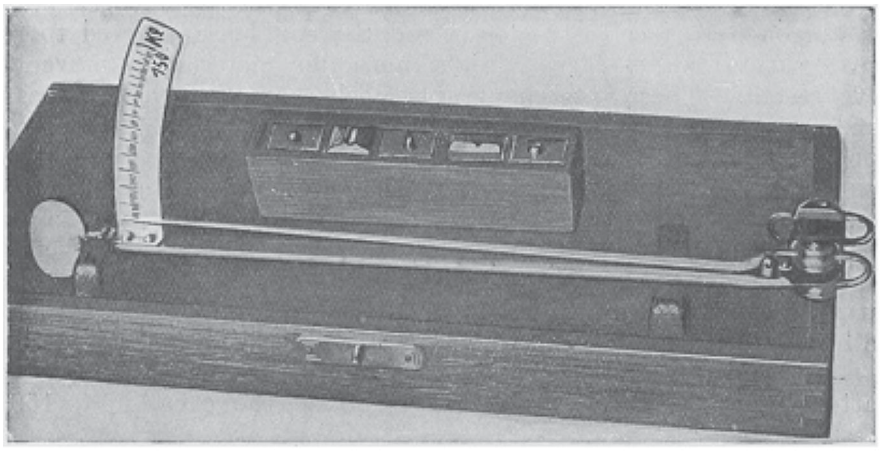
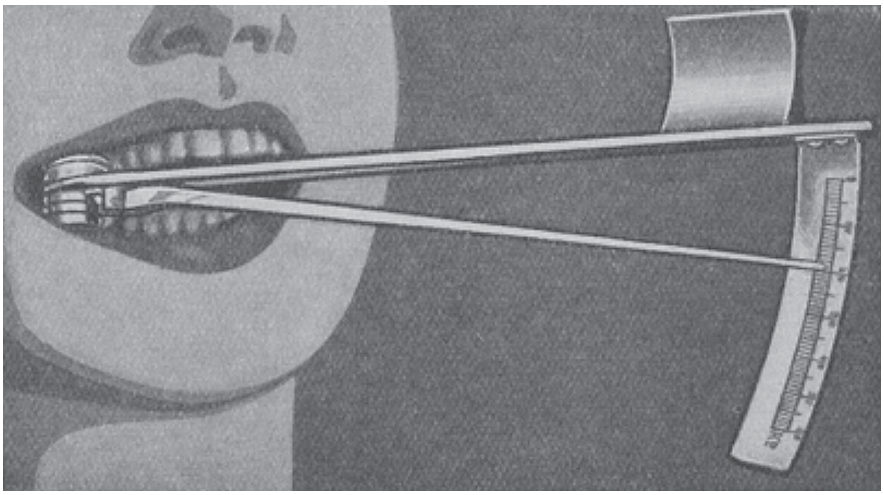


Fig. 3. Haber's gnathodynamometer in use on the right-band side of the mouth [4]



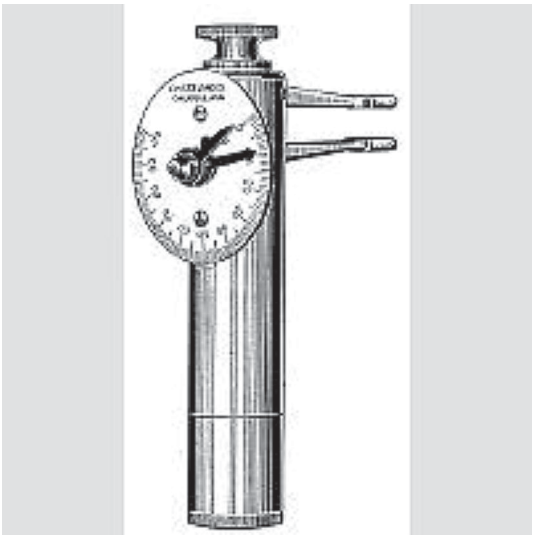
The two patterns are made, one to record up to 50 kg, the other up to 150 kg.

GROUP III was represented by Gnathodynamometers which operate by means of more than one of the three factors - Spring, Lever and Manometer.

In 1920 Giinther bored a hole through each of the shorter ends or jaws of the pliers in which the pin was received and attached to the interchangeable biting plates. The plates were of varying sizes according to the tooth which was to be tested. As a protection to the teeth each plate was covered by a felt pad which could be renewed.

Each of the subsequently created gnathodynamometers was more advanced than the previous one.

Fig. 4. Johnson's gnathodynamometer (1930)



Gnathodynamometers are also used in modern-day experimental studies (Figures 5 and 6) [5, 6, 7].

Fig. 5. Gomis's gnathodynamometer [5].

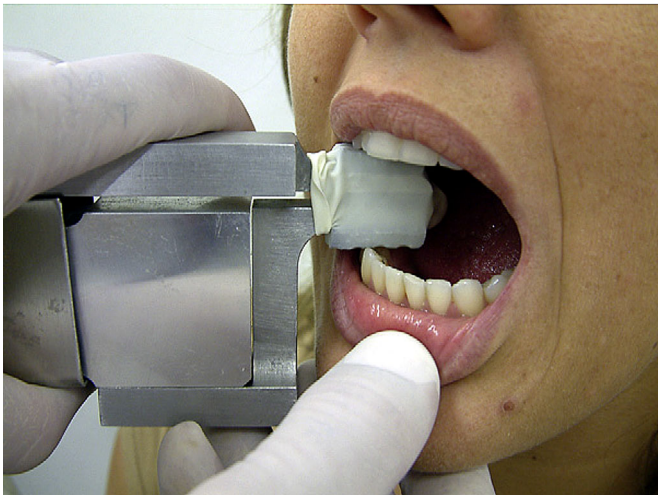


Fig. 6. Measurement of the central incisor's masticatory force of a patient with progenism as per Suzuki [6].

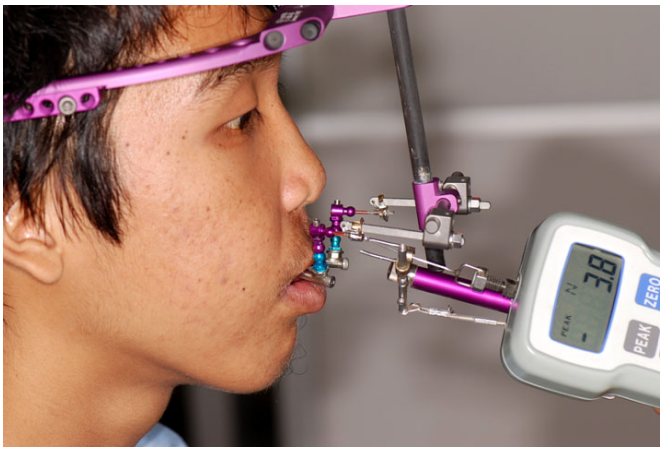
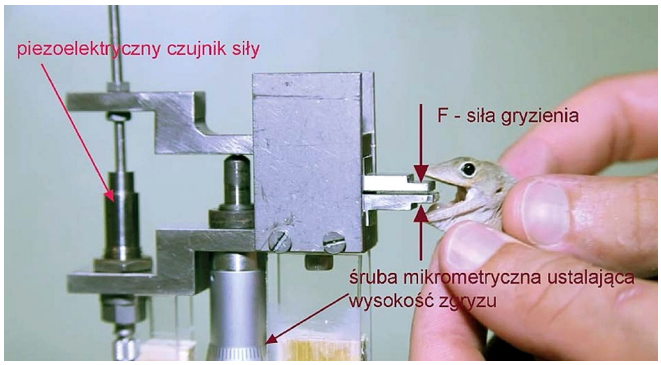


Fig. 7. Gnathodynamometer for animal testing [7].



CONCLUSIONS

The historical review of gnathodynamometric methods enables us to draw the following conclusions:

Gnathodynamometric studies are objective methods for quantitative evaluation of the state of the masticatory apparatus. However, they demand specialized equipment, time-consuming procedures and therefore are quite costly. More accurate results of the study of masticatory function can be obtained by complementing gnathodynamometric methods with another method of examination of the masticatory apparatus.

REFERENCES:

1. Rowlett AE. The gnathodynamometer and its use in dentistry. In: *Proc R Soc Med.* 26. ed 9. 1932–1933 :463.
2. Ortuð G. A new device for measuring mastication force (Gnathodynamometer). *Ann Anat.* 2002 Jul;184(4): 393-396. [PubMed]
3. Uhlig H. Über die Kaukraft. *Dtsch Zahnärztl Z.* 1953; 8:30-45.
4. Haber G. Die Aufgaben Der Kaudruck-Messung- und der Zahndruck-Prüfung. Berlin: Eigenverlag. 1926.
5. Rovira-Lastra B, Flores-Orozco EI, Salsench J, Peraire M, Martinez-Gomis J. Is the side with the best masticatory performance selected for chewing?. *Arch Oral Biol.* 2014 Dec; 59(12):1316-1320. [PubMed] [CrossRef]
6. Suzuki EY, Suzuki B. Assessment of Maxillary Distraction Forces in Cleft Lip and Palate Patients. Intech. 2011 Chapter 2. [CrossRef]
7. Doliński J. [How much bite lizards?]. [in Polish] *Elektronika praktyczna*. 2015; 8:92-94.

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