MECHANICAL INPUT IMPEDANCE OF HUMAN TEETH IN VIVO*

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Abstract—The mechanical input impedance of teeth in vivo has been measured over the frequency range of 60–5000 c/s. A generator was used which delivered a sinusoidal force of variable frequency and constant peak-to-peak amplitude of $4.4 \times 10^4$ dyn. Our data plus those of others indicate that the suspensory apparatus of the tooth consists of several equivalent springs and dampers. The purpose of the initial study is to establish a correlation between some aspect of mechanical impedance and 'clinical mobility' or 'looseness' of teeth. An increase in tooth mobility has long been regarded as a cardinal finding in periodontal disease and a key consideration in determining the feasibility and mode of restoring lost dental function. Finally, we hope to develop a suitable clinical instrument for measuring tooth mobility objectively.

1. INTRODUCTION

Tooth mobility is a sensitive reflector of local connective tissue metabolism. Loosening of the teeth is also reported as an early sign in various generalized systemic diseases. For example, MUEHLEMANN (1951) cites an instance in which cessation of excessive clinical mobility was one of the indications of fetal death in a pregnant woman. Surprisingly, its frequency of occurrence and acknowledged importance as an oral finding have not resulted in development of a clinically practical and satisfactory method of tooth mobility assessment. POLIN (1963) has proposed what appears to be a feasible solution to this problem of objectively measuring tooth mobility routinely in the dental office. This present investigation was stimulated by questions raised in the course of constructing a prototype of Polin's instrument.

The purpose of this paper is to report the results of a series of experiments which we believe answers one of these questions, e.g.: what is the mechanical input impedance of teeth as measured in the usual physical units of impedance? In addition, the results will be compared with clinical mobility as measured by a different means.

2. METHODS

Human teeth in vivo and in a jaw model were caused to move labiolingually by a Wilcoxon Research Model F-3 electrodynamic driver. The force applied by the driver was constant amplitude and sinusoidal with a wave form distortion less than 5 per cent. The resultant motion of the driven tooth was detected by an accelerometer. A force detector, whose signal was used in a feedback loop to hold the peak-to-peak force constant, and an accelerometer constituted an "impedance head" (Wilcoxon Research Model Z-602) which was interposed between the driver and the tooth (Fig. 1).

The impedance head and driver assembly was hung by a 40 cm circumference neoprene "O" ring such that it just touched one of the subject's maxillary incisors. The incisor was cleaned with ethyl alcohol on a cotton swab and a small amount of Tridox Products F-88 "dental cement" was interposed between the tooth and tip of the impedance head. An adequate bond was

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obtained after 10 min. Voluntary immobilization of the subject's head, which was necessary to prevent breakage of the fragile cement bond, was aided by a chin rest, forehead rest and a bite bar (Fig. 2). The procedure for the jaw models was essentially the same.

The models consisted in one case of a lucite block and, in another instance, of a wooden block with 9 mm diameter holes drilled 20 mm deep. The holes were filled with polysulfide rubber base material of the type used to take dental impressions. The mixtures were varied to provide different degrees of resiliency. Extracted human teeth were inserted into the holes so that only the anatomical crowns were exposed.

Figure 3 is a block diagram of the impedance measuring equipment. After the impedance head had been cemented to the tooth the sweep control system was started. This caused the variable frequency oscillator to sweep from 60 to 5000 Hz simultaneously activating the pens of the four X-Y recorders. The amplitude and phase of

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**Fig. 1.** Schematic drawing of electrodynamic driver and impedance head used to measure mechanical input impedance of teeth.

**Fig. 2.** Physical arrangement for tooth impedance measurement.

**Fig. 3.** Block diagram of impedance measuring equipment.