The YEAR BOOK of

Dentistry

1979

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Oral Physiology and Speech

Viscoelastic Properties of the Periodontal Ligament and Mucous Membrane. D. C. A. Picton and D. J. Wills[1] (Univ. College Hosp. Dental School, London) demonstrated in monkeys the viscoelastic properties of groups of teeth as they might be loaded by a tooth-borne prosthesis and of regions of mucosa comparable with that supporting a tissue-borne prosthesis. Studies were done in 3 adult *Macaca irus* monkeys. A linear variable displacement transducer was attached to the posterior maxillary teeth after preparation of baseplates fitted to the maxillary incisors and cuspids (Fig 1). One was a tissue-borne plate with resin cut away from the teeth and from within 1 mm of the gingival crest. Forces with different loading rates, creep and simulated chewing loads were applied to the plates, and displacement was measured electronically relative to posterior teeth.

The chief viscoelastic features observed by others for individual teeth under load were confirmed for the test plates. The displacement and recovery of the tooth loaded as a ramp function corresponded with the force-displacement relation of a typical viscoelastic material. Loads sustained for some time caused creep. The rate of loading and the displacement were inversely related. The higher the rate of loading, the less was the distinction between early and late phases of displacement. Recovery became more incomplete if loadings were repeated at intervals of less than 1½ minutes. The rate of recovery was directly related to the loading rate and indirectly related to the duration of loading. These features could be attributed to the connective tissues in the periodontium and in the mucosa. The magnitude of displacement of the tissue-borne plate was appreciably greater than for the tooth-borne plate and the recovery was far slower. Reduction of the part of the plate in contact with mucosa produced greater

(1) J. Prosthet. Dent. 40:263–272, September, 1978.

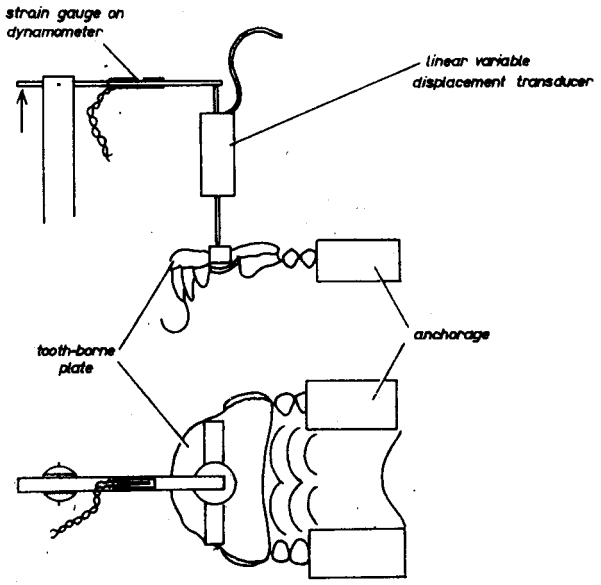


Fig 1.—Experimental design. (Courtesy of Picton, D. C. A., and Wills, D. J.: J. Prosthet. Dent. 40:263–272, September, 1978.)

intrusion, and reduction of the number of teeth supporting the tooth-borne plate produced greater displacement.

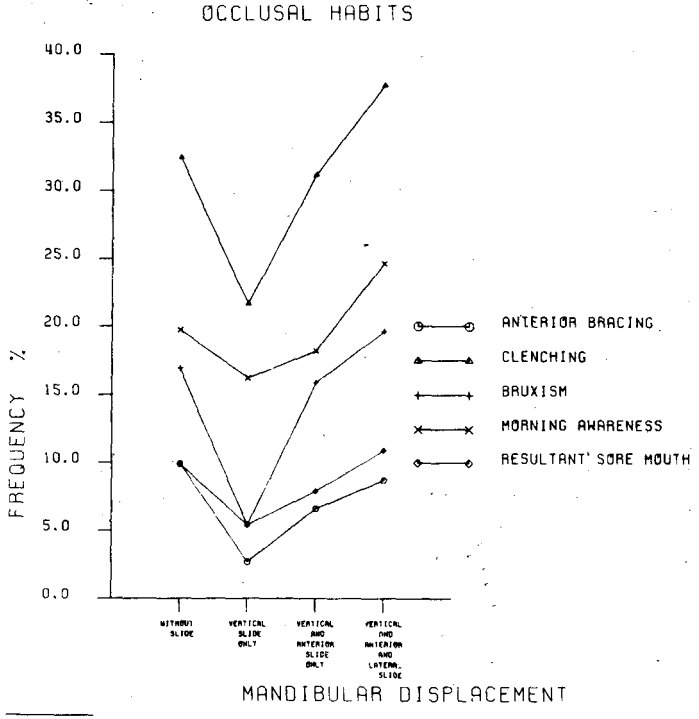
► [This discussion of the viscoelastic properties of mucosa and periodontal ligament, describing the slow recovery after intermittent but sustained loading, suggests that distortion of mucosa and ligament may be associated with loss of fit (adaptation) of the prosthesis. This maladaptive fit may in turn cause malocclusion stress inducing further deformation of tissue. The net effect of these summed distortions could be mucosal inflammation and loss of underlying bone. When teeth are present, the tissue distortion could cause mobility and an ill-fitting prosthesis. It is therefore suggestive that loading patterns be evaluated. Perhaps people should remove prostheses during the night and even during the daytime to allow full recovery of mucosal form!—S.I.S.] ◄

Frequency of Parafunctional Occlusal Habits Compared with Incidence of Mandibular Displacement. A high incidence of parafunctional occlusal habits has been found in various populations, and there is also evidence of a high prevalence of mandibular displacement. Carl E.

Rieder[2] (Univ. of Southern California) studied the relation of mandibular displacement and parafunctional activity in 557 adults, 60% of them women. Most were professional persons and housewives. A temporomandibular joint examination form and patient questionnaire were completed. Mandibular displacement from retruded contact position (RCP) to intercuspal position (IP) was measured.

About one eighth of subjects showed no mandibular displacement. Over half had a vertical and anterior slide from RCP to IP. Nearly a fourth showed vertical, anterior and lateral components in their displacements. Clenching was

Fig 2. – Composite of prevalence of parafunctional occlusal habits and some sequelae, compared with absence and increasing complexity of mandibular displacement, in 577 patients. (Courtesy of Rieder, C. E.: J. Prosthet. Dent. 40:75–82, July, 1978.)



(2) J. Prosthet. Dent. 40:75–82, July, 1978.

the most prevalent parafunctional habit in the 71 patients with no mandibular displacement and in the 37 with only vertical displacement. Clenching was also most prevalent in the 302 patients with both vertical and anterior components of displacement, followed by morning awareness and bruxism. Clenching was also most prevalent in the 138 patients with all three components of displacement. The prevalence of any given habit or sequela was highest in patients with the most complex mandibular displacements, except for those with no apparent mandibular slide who also had a history of a high prevalence of parafunctional habits and sequelae (Fig 2).

The prevalence of occlusal habits was high in all groups in this study and increased with increasing complexity of the mandibular displacement, particularly an asymmetric slide from RCP to IP. The multifactorial etiology of parafunctional occlusal habits and their sequelae tends to make the relations more complex than simple "cause and effect."

► [The increasing prevalence of parafunctional occlusal "habits" with increasing complexity of mandibular displacement in both horizontal and vertical planes is clinically significant. However, the so-called "gap" distance between retruded contact position and the intercuspal position is probably not the causative process in habit formation, because about 90% or more non-"habit" patients have this difference. I believe it is the unilateral or premature contact in one or both of these planes of reference that relates to the habit problem. The glide or positional distortion of the mandible relates to a cyclical stimulus for initiating and reinforcing a habit formation. Adjusting the prematurity and restoring bilateral simultaneous contact relationships in both the retruded contact position and the intercuspal position contribute significantly to the reduction of the "habit" process. Perhaps bilateral simultaneous occlusion contact in all positions from retruded contact position to the protrusive incisal contact position is the critical treatment in reducing "habit" formation patterns.—S.I.S.] ◄

Bite Force and State of Dentition. Eva Helkimo, Gunnar E. Carlsson and Martti Helkimo[3] measured maximal bite force and other medical and odontologic parameters in a group of Lapps in the north of Finland to devise a simple method of measuring bite force for use in field studies and to examine relations between bite force and state of the dentition, functional state of the masticatory system and general muscle strength. Studies were done in 68 female and 57

(3) Acta Odontol. Scand. 35:297–303, 1977.

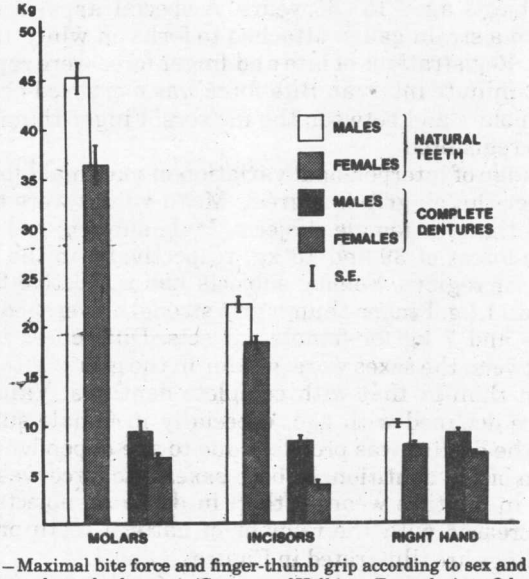
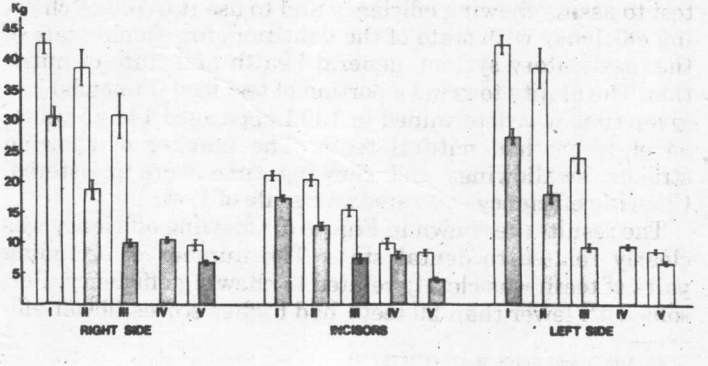


Fig 3. – Maximal bite force and finger-thumb grip according to sex and dental status (means and standard errors). (Courtesy of Helkimo, E., et al.: Acta Odontol. Scand. 35:297–303, 1977.)

Fig 4. – Maximal bite force of male *(open bars)* and female *(stippled bars)* subjects according to age and dental status (means and standard errors). *I*, dentate aged 15–25 years; *II*, dentate aged 26–39 years; *III*, dentate aged 40 years or over; *IV*, complete upper denture and residual natural teeth in lower jaw; *V*, complete upper and lower dentures. (Courtesy of Helkimo, E., et al.: Acta Odontol. Scand. 35:297–303, 1977.)



male subjects aged 15–65 years. A special apparatus was used with a strain gauge attached to forks on which the patient bit. Registrations of bite and finger force were repeated after a 2-minute interval. Bite force was measured between the 1st molars and between the incisors. Finger-thumb grip was also registered.

The range of interpersonal variation of maximal bite force and finger-thumb grip was great. Mean values were higher for male than for female subjects. Male subjects had maximal bite forces of 39 and 18 kg, respectively, in the molar and incisor regions. Female subjects had respective figures of 22 and 11 kg. Finger-thumb grip strength averaged 10 kg for male and 7 kg for female subjects. Differences in bite force between the sexes were greater in the group with natural teeth than in that with complete dentures. Values for bite force declined with age, especially in female subjects; most of the decline was probably due to age-dependent deterioration of the dentition. In both sexes bite force was notably less in denture wearers than in dentate subjects. Bite force increased with the number of natural teeth present. The findings are illustrated in Figures 3 and 4.

The observation of substantially lower bite force in denture wearers than in others strengthens the impression that loss of the natural teeth implies an oral handicap that can only partially be compensated by removable prostheses.

Chewing Efficiency and State of Dentition: Methodological Study. Eva Helkimo, Gunnar E. Carlsson and Martti Helkimo[4] undertook to devise a simple, reproducible test to assess chewing efficiency and to use it to relate chewing efficiency with state of the dentition, functional state of the masticatory system, general health and state of nutrition. The ability to grind a portion of test food (almonds) in a given time was determined in 139 Lapps aged 14–65 years, 94 of whom had natural teeth. The number of chewing strokes, swallowings and chewing time were registered. Chewing efficiency was rated on a scale of 1–5.

The results are shown in Figure 5. Chewing efficiency was clearly related to dental state. The number of occluding pairs of teeth was closely related to chewing efficiency. Persons with fewer than 20 teeth had higher scores (lower effi-

4) Acta Odontol. Scand. 36:33–41, 1978.

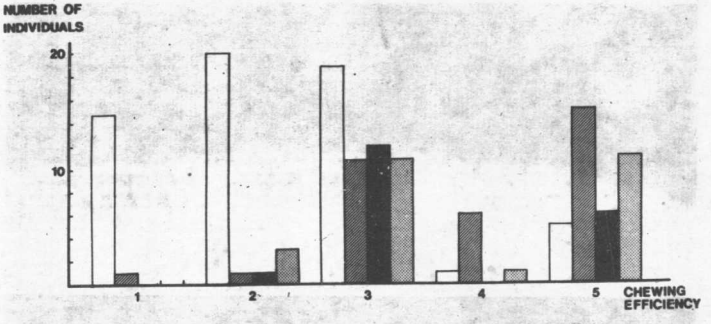


Fig 5. – Distribution of material in respect of different chewing efficiency groups: *open bars*, more than 20 teeth; *hatched bars*, 20 or fewer teeth; *solid bars*, complete upper denture or upper removable partial denture with natural teeth in lower jaw; *stippled bars*, complete upper and lower dentures. (Courtesy of Helkimo, E., et al.: Acta Odontol. Scand. 36:33–41, 1978.)

ciency) than those with more teeth. Fewer chewing strokes and swallowings and shorter chewing times were associated with good chewing efficiency. Denture wearers had significantly lower chewing efficiency than subjects with natural teeth and they required more chewing time before swallowing.

The claim that poor chewing efficiency is compensated by swallowing less well ground food, not by chewing longer, was partly corroborated in this study. Chewing efficiency was not significantly correlated with rate of chewing.

Sensory Mechanism in Human Dentin as Revealed by Evaporation and Mechanical Removal of Dentin. A mechanism for transmission of pain-producing stimuli to the pulp region via the dentinal tubules must exist. M. Brännström and G. Johnson[5] (Karolinska Inst., Stockholm) sought to determine whether mechanical work in the form of chiseling off the dentin can result in an outward flow in the dentinal tubules, as revealed by the displacement of odontoblast nuclei into the tubules and pain, and whether "normal" evaporation from exposed dentin may result in pain and aspiration of odontoblasts into the dentinal tubules. Studies were done in 39 pairs of premolars in young subjects, which were to be removed for orthodontic reasons.

5) J. Dent. Res. 57:49–53, January, 1978.

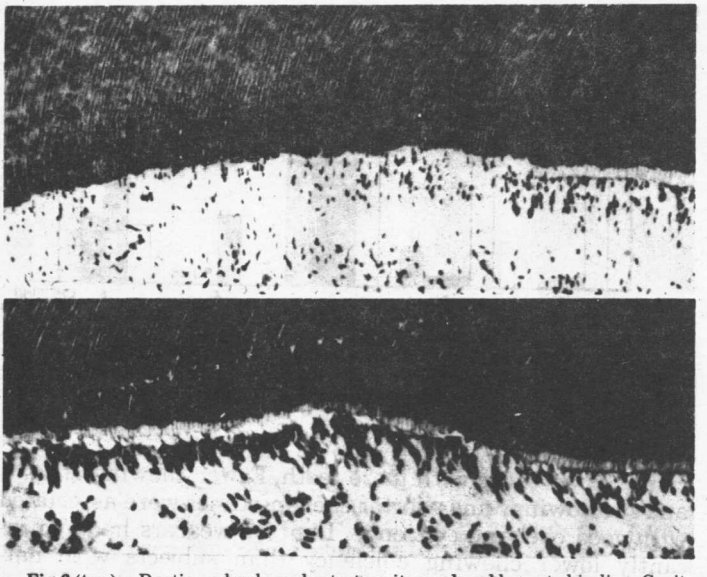


Fig 6 (top).—Dentin and pulp under test cavity produced by wet chiseling. Cavity left dry for 4 minutes. Pain reaction after 4 seconds. Numerous odontoblasts aspirated into tubules. Control area under unexposed dentin to right. Hematoxylin; original magnification ×330.

Fig 7 (bottom).—Tooth contralateral to that in Figure 6. Dentin and pulp under control cavity produced by wet chiseling and kept wet. No nuclei are seen in dentinal tubules. Pulpodentinal membrane lost. Increased basophilia in odontoblast layer, slightly separated from predentin wall. Control area under unexposed dentin to right. Hematoxylin; original magnification ×120.

(Courtesy of Brännström, M., and Johnson, G.: J. Dent. Res. 57:49–53, January, 1978.)

Enamel in the middle of the buccal surfaces was carefully ground away, either dry or under a continuous flow of water. Chiseled surfaces were either exposed to physiologic saline or left dry for 4 minutes.

Damaged odontoblast layers and cell nuclei in the dentinal tubules were seen under the dentin surface that was chiseled dry. An interrupted pulpodentinal membrane and basophilia in the odontoblast layer were seen under exposed dentin surfaces that were chiseled wet. A few cell nuclei were seen in the dentinal tubules in 6 of 24 instances. Shooting pain occurred, with both wet-chiseled and dry-chiseled den-

tin, during the entire chiseling procedure. Dry chiseling usually caused greater pain than wet chiseling. The effects of dryness and continuous moisture are compared in Figures 6 and 7. Shooting pain usually occurred on "normal" evaporation for 4 minutes, but no pain was reported from moistened control teeth. Pain stopped in test teeth when the exposed dentin was remoistened. The test teeth with the longest period of pain showed the most extensive aspiration of cells into the underlying dentinal tubules.

Chiseling of dentin should be done with the continuous addition of water to reduce pain and avoid loss of odontoblasts. Pain associated with chiseling off dentin, probing and initial drilling may be due to removal of fluid from the dentinal tubules.

► [Though the results of this study might be assumed to be academic when related to preparation of tooth surfaces that are "protected" by use of local anesthesia, the findings are of interest and may hold a key to certain instances of postoperative discomfort.—D.F.R.] ◄

Conditioning Prostheses Viewed from the Standpoint of Speech Adaptation. A new prosthesis or orthodontic appliance requires a period of physiologic adjustment by the patient. Sandra Hamlet, Maureen Stone and Thomas McCarty[6] (Univ. of Maryland) determined whether a prosthesis to which a subject previously adapted would induce the same physiologic compensations when reinserted after a time. Four women and 3 men, all young adults with normal speech, were studied. None had had orthodontic treatment or experience in speaking with dental prostheses. An acrylic resin alveolar-palatal prosthesis was constructed for each subject, and a second prosthesis was made with electrode contacts. A set of short phrases was used as the speech sample. Jaw activity, tongue-palate contacts and voice were recorded. Tongue-palate contacts were monitored by dynamic palatography. The prosthesis was worn for 2 weeks before retesting, and a further recording session was scheduled about a month later.

The subjects were able to speak naturally with their prostheses after a 1-month interval. Data on jaw motions and tongue-palate contacts during speech indicated rapid return to compensatory articulatory patterns. A subject who

(6) J. Prosthet. Dent. 40:60–66, July, 1978.

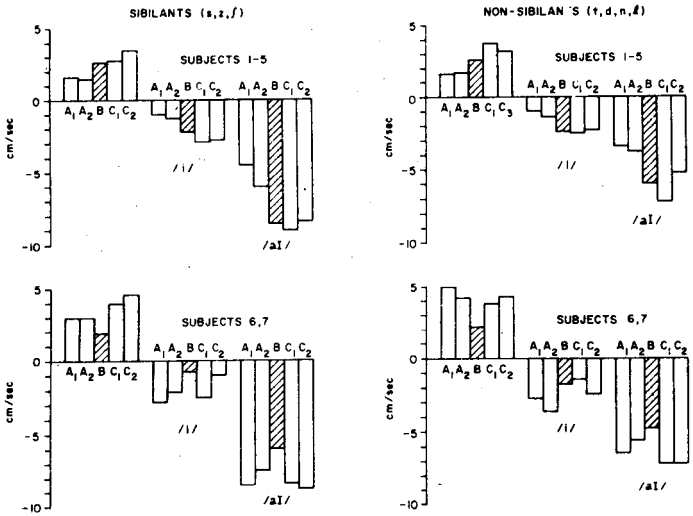


Fig 8. – Median values of maximum jaw velocities. Positive values are peak closing velocities going into consonant. Negative values are peak opening velocities going into /i/ or /aI/. Breakdown is according to sibilants or nonsibilants and other subjects increasing or decreasing jaw velocity as adaptive pattern. (Courtesy of Hamlet, S., et al.: J. Prosthet. Dent. 40:60–66, July, 1978.)

had adapted to the experimental prosthesis over a week made the same type of compensatory jaw adjustments when speaking with the prosthesis again 1 year later. Jaw velocity data are given in Figure 8.

The findings support the assumption that speech motor patterns can survive for many years in the absence of natural teeth. The use of phonetics is not objectionable in determining denture design, but the speech gestures used in refining denture design may not be identical with those used when the natural teeth are present. A conditioning prosthesis producing the same oral contour as the final one should allow a patient to achieve speech adaptation in advance and retain the new speech facility over an extended period.

► [I am pleased to review an article published by 3 speech pathologists and to comment on the methodology and instrumentation now available to dentistry when the speech function is being studied. The authors used 7 college-age students with obviously healthy intact oral structure and dental arch configuration. The test experience did not cope with degener-