A Step Toward Setting Norms: Comments on the Occlusal Interface

Alain Woda, DDS, PhD

Alain Woda was first trained as a dentist before earning a PhD in neurosciences in 1978 at the University of Paris VI. As a professor on the dental faculty of the University of Clermont-Ferrand, France, he developed a laboratory focused on the physiology of the orofacial area. His interests have ranged from the basic neurophysiology of pain to the interfaces between basic sciences and clinical dentistry, including occlusion. He is presently running a consultation for patients with different types of orofacial pain. His more recent works have been devoted to adaptation and impairment of the masticatory process and to the treatment of burning mouth syndrome. He is an associate editor of the *Journal of Orofacial Pain.*

In the last few decades dental practitioners have widely gained the respect of other health professionals, or at least greater self-confidence, through 2 independent trends. First, pure scientists in dentistry have joined the mainstream of science. In many fields, they have reached the highest levels of achievement and have mixed with scientists from other areas of research. Second, professional and academic clinicians have reached high levels of clinical performance and have mastered complex and sophisticated techniques in patient treatment. But this progress, as always, has a downside. Dental scientists have sometimes focused on pure research remote from possible care applications, while, as noted by several contributors to the proceedings of the symposium, subjective and specious theories or concepts have bloomed, particularly in prosthodontics, in support of clinical methods that are not based on any real evidence. The various contributions that compose the proceedings of the 2003 symposium offer what is, in my view, a most accomplished illustration of a third trend in dental science: an endeavor to build a core of knowledge that is both scientific, ie, evidence based, and focused on clinical problems.

One ultimate goal is to demonstrate the efficacy of old or new treatment strategies. This usually requires well-matched control groups, but these are not easy to assemble. Defining inclusion criteria for both the test and control groups requires knowing who is healthy and who is not and what their illnesses are. In other words, the description of pathology must refer to normality, ie, a situation characterized by healthy functions. In turn, and to use examples from the field of occlusion, any assessment of the effect of the rehabilitation of either the occlusal contacts or the habitual mandibular posture must be made relative to pathologic conditions that are as well-described and as well-understood as possible. In trying to achieve such a scientific description of normality and pathology, several issues arise:

1. Occlusion may not offer a sound basis for defining normality of oral function

Occlusion is the most common interface met by a dentist observing the masticatory apparatus. Because dentists can act on it, the part has replaced the whole. Similarly, neurologists are especially interested in tongue mobility, while otorhinolaryngologists are primarily concerned by how the bolus is swallowed. Occlusion is not in itself a function. It has no single, individual, well-defined goal. It qualifies a tooth-to-tooth articulation that participates, along with many other organs, in the comminution of food to prepare a bolus for swallowing. The masticatory-deglutition function, viewed from a clinically meaningful point of view, should be the physiological reference for the dental profession, and more work is needed in this direction. Many studies have focused on the analysis of the food bolus to evaluate chewing performance in terms of the individual's ability to break down a standardized test food.[1,2] In these studies, the subjects were instructed to chew for a predetermined time, for a predetermined number of strokes, or until they felt they could swallow the bolus.[3,4]

Another approach is to consider the final state of the food bolus. To be safely swallowed, the food bolus must be smooth, plastic, and cohesive.[5] These properties are mandatory to facilitate a nonharmful passage through the aerodigestive crossing. A noncohesive bolus favors dysfunctional deglutition with particle aspiration into the airways and leads to serious respiratory problems and a high morbidity level.[6–10] Recent studies have shown that in young healthy subjects the particle size distribution of ready-to-swallow food boluses displays narrow interindividual variability. This contrasts with the wide variability of the parameters characterizing the masticatory function.[11] The fact that a food bolus must meet precise conditions before swallowing can be triggered is therefore interpreted as reflecting a key factor for homeostasis. Hence the masticatory-deglutition function can be considered normal when the goal of making a food bolus with the correct particle size distribution is reached. The values of the particle sizes just before swallowing can therefore be used as an indicator of the performance of the mastication-deglutition function. This could form, in the future, the basis of a simple test to evaluate masticatory function in a standard clinical situation.

Many of the patients receiving dental care present no or very little masticatory impairment. Temporomandibular joint–disordered or edentate persons display only mildly impaired mastication. However, many other subjects cannot produce an adequate food bolus because they suffer from masticatory impairment with occlusal, neurological, muscu-

lar, or psychosocial components. Disabled and very old persons, and subjects with large dysmorphic jaws, need treatment and at the same time offer valuable models of abnormal function. They have much to teach us because they will help us define normality.

2. Reference to Beyron's criteria is a great step forward, or at least may reverse a great step back

The interaction between functional tooth contacts, occlusal stability, and dental wear has rehabilitated old concepts defended by Beyron[12–14] and many others,[15–18] who based their conclusions on the observation of the skeletons of "archaic" or ancient populations. These concepts were forgotten between the 1960s and 1990s, mainly because they were upstaged by new technology. Gnathology, however, developed on poor scientific grounds. Many neurophysiological arguments were advanced in a very naive way. The fine and very delicate sensitivity of the periodontal ligament[19] was invoked to support an eccentric occlusion, with canine and anterior teeth not supporting any forces but guiding the jaw movements until centric occlusion could be reached. The deeply worn occlusal surfaces observed in ancient or archaic populations, however, indicate that strong forces are involved in mastication. Forceful tooth-to-tooth guidance creates the wear facets that guide the jaw during the occlusal phase of chewing. In addition, the direction of the jaw movements during the occlusal phase vary from one cycle to another, as indicated by the many directions of the wear scratches left by the mandibular molars as they glide on the maxillary occlusal surfaces[20] and by the telemetric recording of the occlusal phase of jaw movement.[21] These findings agree with the old description of the "pestle in a mortar" action crushing the food but do not support a purely mechanical view. Accurate proprioceptive feedback which allows fine control of force intensity[22,23] rather in the way that a carver will remove wood with a gouge to create a desired shape, is also in play.

Similarly, the condition of mandibular posture is often viewed simplistically. Miles et al have recently shown that jaw jerk reflex is not at work while subjects are walking or standing.[24] Jaw jerk reflex does regulate the mandibular rest position, but only when the jaw is briskly moved such as during running. This means that in a quiet situation, other forces play a role, such as the viscoelasticity of the muscle and a centrally driven tonic activity. It is necessary to explore the idea that the mandibular position depends on a pre-existing central representation of the body schema, which itself depends on sensory information or comparison with it. In this sensitive reference, a stable occlusion with simultaneous upper teeth-lower teeth contacts could serve as a sensorial reference, playing the role of neck proprioception for head position or gravity for the whole body.[25]

3. A norm still lies some way ahead

Many questions remain unanswered. What is the role of mastication in the general economy of the body? Whether it has a major role in nutrition apart from preparing for deglutition is not clear, and only indirect and not fully convincing evidence has suggested that poor mastication may lead to nutritional insufficiency in debilitated subjects.[26,27] A recent well-devised epidemiologic study suggests that some such role does exist.[28] The risk of developing deficient mastication via malnutrition is also not clearly proven.[26,27]

The need for valid criteria for the diagnosis of bruxism and for its possible role in the etiology of TMJ disorders was emphasized in the symposium,[29,30] but the significance of bruxism is still not settled. Great advances have come from polysomnic recordings,[31,32] which show that intermittent and spontaneous masticatory muscle activities at night are normal. It is therefore possible that "bruxers" are merely individuals at the edge of a gaussian distribution. This would mean that spontaneous muscle activity is a trivial activity, the role of which is unknown, instead of a "parafunctional activity" found exclusively in a few subjects.

As stated above, intensive occlusal and proximal wear were physiologic norms in ancient and archaic populations, and there is no serious reason to believe that human physiology has changed with modernity. Indeed, it has been shown that in modern Western populations all the teeth in healthy dental arches display wear facets.[33] Questions remain, however. If the teeth are made to become deeply worn, as observed in many non-Western societies, what are cusps for? Perhaps they exist for mechanical guidance for eruption or enhancement of the grinding power of the teeth, but this theory has not been substantiated. Another general point is that physiologic and social norms may differ. High levels of dental wear, for example, are certainly the physiological norm but are reluctantly accepted in our society. In addition, chemical attack can bring about marked dental tissue losses that are not physiological at all.[34]

The process of compensation for attrition by supraeruption is well known,[15,18] but it is not known whether supraeruption compensates exactly for crown reduction by attrition. The lifestyle of the ancient Inuits caused complete destruction of tooth crowns in many individuals by chewing-induced dental wear. Surprisingly, the occlusal vertical dimension was maintained. This was explained by a vertical alveolar growth that was reinforced by the intense stimulation during chewing. A totally different situation was demonstrated by a transversal study conducted in modern Finnish women, who showed very little dental wear. A progressive increase in the occlusal vertical dimension was observed with aging, which was explained by spontaneous alveolar growth independent of dental wear.[35] These different processes—alveolar growth, continuous dental eruption, bone stimulation through chewing forces and resulting dental wear—need further study so that we may gain a fuller understanding of how they interact.

References

1. English JD, Buschang PH, Throckmorton GS. Does malocclusion affect masticatory performance? Angle Orthod 2002;72:21–27.
2. Ngom PI, Diagne F, Aidara-Tamba AW, Sene A. Relationship between anomalies and masticatory function in adults subjects. Am J Orthod (in press).
3. Hatch JP, Shinkai RSA, Sakai S, Rugh JD, Paunovich ED. Determinants of masticatory performance in dentate adults. Arch Oral Biol 2001;46:641–648.
4. Fontijn-Tekamp FA, van der Bilt A, Abbink JH, Bosman F. Swallowing threshold and masticatory performance in dentate adults. Physiol Behav 2004;83:431–436.

5. Prinz JF, Lucas PW. An optimization model for mastication and swallowing in mammals. Proc Biol Sci 1997;264:1715–1721.
6. Gilmore SA, Robinson G, Posthauer ME, Raymond J. Clinical indicators associated with unintentional weight loss and pressure ulcers in elderly residents of nursing facilities. J Am Diet Assoc 1995;95:984–992.
7. Gleeson DCL. Oropharyngeal swallowing and aging: A review. J Commun Disord 1999 32:373–395.
8. Johnston BT, Li Q, Castell JA, Castell DO. Swallowing and esophageal function in Parkinson's disease. Am J Gastroenterol 1995;90:1741–1746.
9. Cook SP, Lawless S, Mandell GA, Reilly JS. The use of the salivagram in the evaluation of severe and chronic aspiration. Int J Pediatr Otorhinolaryngol 1997;41:353–361.
10. Hennequin M, Allison PJ, Veyrune JL. Prevalence of oral health problems in a group of individuals with Down syndrome in France. Dev Med Child Neurol 2000;42:691–698.
11. Peyron MA, Mishellany A, Woda A. Particle size distribution of food boluses after mastication of six natural foods. J Dent Res 2004;83:578–582.
12. Walther W. Determinants of a healthy aging dentition: Maximum number of bilateral centric stops and optimum vertical dimension of occlusion. Int J Prosthodont 2003;16(suppl):77–78.
13. Nilner M. Musculoskeletal disorders and the occlusal interface: II. Int J Prosthodont 2003;16(suppl):85–86.
14. Beyron H. Occlusion: Point of significance in planning restorative procedures. J Prosthet Dent 1973;30:641–652.
15. Murphy TR. The progressive reduction of tooth cusps as it occurs in natural attrition. Dent Pract Dent Rec 1968;19:8–14.
16. Begg PR. Stone age man's dentition. Am J Orthod 1954;40:298–312.
17. Hildebrand GY. Studies in mandibular kinematics. Dent Cosmos 1936:449–459.
18. Levers BGH, Darling AI. Continuous eruption of some adult human teeth of ancient populations. Arch Oral Biol 1983;28:401–408.
19. Jerge CR. Organization and function of the trigeminal mesencephalic nucleus. J Neurophysiol 1963;26:379–392.
20. Morel A, Albuisson E, Woda A. A study of human jaw movements deduced from scratches on occlusal wear facets. Arch Oral Biol 1991;36:195–202.
21. Pameijer JH, Glickman I, Roeber FW. Intraoral occlusal telemetry: 3. Tooth contacts in chewing, swallowing and bruxism. J Periodontol 1969;40:253–258.
22. Peyron MA, Lassauzay C, Woda A. Effects of increased hardness on jaw movment and muscle activity during chewing of viscoelastic model foods. Exp Brain Res 2002;142:41–51.
23. Ottenhoff FAM, van der Bilt A, van der Glas HW, Bosman F. Control of elevator muscle activity during simulated chewing with varying food resistance in humans. J Neurophysiol 1992;68:933–944.
24. Miles TS, Flavel SC, Nordstrom A. Control of human mandibular posture during locomotion. J Physiol 2004;554:216–226.
25. Massion J, Amblard B, Assaiante C, Mouchnino L, Vernazza S. Body orientation and control of coordinated movements in microgravity. Brain Res Brain Res Rev 1998;28:83–91.
26. N'gom PI, Woda A. Influence of impaired mastication on nutrition. J Prosthet Dent 2002;87:667–673.
27. Hutton B, Feine J, Morais J. Is there an association between edentulism and nutritional state? J Can Dent Assoc 2002;68:182–187.
28. Sheiham A, Steele JG, Marcenes W, et al. The relationship among dental status, nutrient intake, and nutritional status in older people. J Dent Res 2001;80:408–413.
29. Koyano K, Tsukiyama Y, Ichiki R. Local factors associated with parafunction and prosthodontics. Int J Prosthodont 2003;16(suppl):82–83.
30. Lavigne G, Kato T. Usual and unusual orofacial motor activities associated with tooth wear. Int J Prosthodont 2003;16(suppl):80–82.
31. Lavigne GJ, Rompre PH, Montplaisir JY. Sleep bruxism: Validity of clinical research diagnostic criteria in a controlled polysomnographic study. J Dent Res
32. Baba K, Haketa T, Sasaki Y, Ohyama T, Clark GT. Association between masseter muscle activity levels recorded during sleep and signs and symptoms of temporomandibular disorders in healthy young adults. J Orofac Pain (in press).
33. Woda A, Gourdon AM, Faraj M. Occlusal contacts and tooth wear. J Prosthet Dent 1987;57:85–93.
34. Bartlett DW. Erosion and tooth surface loss. Int J Prosthodont 2003;16(suppl):87–88.
35. Tallgren A. Changes in adult face height due to ageing, wear and loss of teeth and prosthetic treatment. Acta Odontol Scand 1957;15(suppl) 24:1–122.