

Guest editorial

The interaction of function and stability in the dentition

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The human dentition sustains two functions of biological significance: it has a central role in the masticatory system, and plays a complementary role in anterior tooth display and the expression of emotion essential in social communication and social signalling.

In the first function the teeth within and on opposing dental arches, i.e. the occlusion, bear direct physical loading during maturation, adulthood and aging. Thus occlusal function and occlusal stability, long viewed as discrete goals of orthodontic treatment are, in reality, each part of the ultimate objective: to ensure the life-long function, stability and physiological integrity of the dentition as an organ system.

A hundred years ago, when orthodontics was in its infancy in the United States, the lofty though difficult goal of dentistry was to preserve the natural dentition for a lifetime. In one respect the task was less formidable than it is today given that the average life span at the turn of the 20th century was approximately 30 years shorter than it was at the beginning of the 21st century. Ushering in the modern era in dentistry, I.B. Davenport, G.V. Black, W.G.A. Bonwill, E.H. Angle, C.S. Case and many other dentists of the late 19th century came to think that the key to the preservation of an intact dentition is stable occlusion. The greatest threat to a stable occlusion at that time was tooth loss due to caries or pyorrhoëa, as periodontal disease was then called. Difficult though it is to imagine now, mutilated dentitions were far more common than intact dentitions after 20 or 30 years of age during this period in relatively recent dental history.

Conviction that proximal contact and occlusal intercuspation of teeth, and stability of tooth position and occlusion are fundamental to the long-term maintenance of the dentition led Angle to propose that the 'science of occlusion' serve as the basis of clinical dentistry.¹ The observation that premature loss of one or more permanent teeth may cause adjacent and opposing teeth to migrate or drift in more or less predictable fashion prompted the conclusion that

mutilated dentitions are unstable. Yet even mutilated dentitions over time acquire stability, leading to the obvious conclusion that the dentition exists in a state of dynamic equilibrium. Angle's further supposition was that intercuspation of posterior teeth is responsible for tooth stability and it was hoped that the study of the science of occlusion would illuminate the factors responsible for stability or instability.

Early orthodontists observed that positional change effected by orthodontic tooth movement almost always led to some degree of instability; thus did the term relapse become part of the orthodontic lexicon. Yet even if badly malposed, a tooth in equilibrium may attain a stable position. It is said that this observation prompted Angle to remark somewhat facetiously, 'There is nothing as stable as a malocclusion'! Another early orthodontist, it is reported, offered that he would happily treat any malocclusion as long as someone else supervised its retention. Regrettably, a broader concept of stability and relapse in clinical orthodontics has diminished in attention over the last 50 years; today the term 'relapse' often merely conjures post-treatment crowding of mandibular incisors. Important though this is to practising orthodontists it diverts attention from the crucial and vital element of stability within the whole dentition as a long-term objective of orthodontic treatment.

Angle's assertion that intercuspation of posterior teeth is the major factor in tooth stability has proved to be incorrect.² We know now that teeth are positioned in a state of equilibrium within the enveloping soft tissues. Indeed during normal masticatory function the food bolus is prepared with no more than transitory occlusal contact during swallowing. On the other hand, occlusal contact does occur in almost everyone in brief clenching and grinding during REM sleep, and some individuals have prolonged parafunction.

How much does occlusion really contribute to long-term health and stability of the dentition? Until fairly recently an unstable occlusion was thought to promote the onset of periodontal disease, a misinterpretation of presumed cause and effect. In fact, teeth drift

because of loss of periodontal attachment resulting from periodontal disease, not vice versa. It was considered also that traumatic occlusion is a primary factor in causing periodontal disorder; it is recognised now that occlusal trauma, if associated with a periodontal problem is a secondary, not primary, factor in its causation. There is also no evidence that improving occlusion with orthodontic treatment enhances periodontal health.^{3,4}

Another likely misinterpretation of the role of occlusion in oral health resulted from the potentially erroneous conclusion about the 'high filling' effect. Here, when a restoration creates a premature occlusal contact, the patient invariably develops tooth pain lasting days or even weeks. The conclusion drawn was that faulty occlusion created micro-trauma, a primary factor in causing pulpal hyperaemia, as well as periodontal lesions. But in orthodontic practice today composite is often added to the occlusal surfaces of posterior teeth temporarily to serve as temporary mini-bite planes with patients rarely complaining of dental pain. Pulpal hyperaemia associated with a high filling is likely the result of caries removal during tooth preparation for restoration, with occlusal trauma being a secondary or compounding factor in causing pain.

The same kind of misinterpretation of causality has been responsible for an incorrect conclusion regarding the relationship between occlusion and temporomandibular joint disorder (TMD). It is now widely accepted that flawed occlusion is not a primary factor in causing TMD. In some individuals, occlusal prematurities may lead to the parafunctional habit of clenching or bruxing, thereby causing secondary muscle spasm, fasciitis or tendonitis resulting in pain in the region of the joint. There is no evidence that one specific occlusal arrangement offers an advantage over another by way of enhanced function of the dentition (e.g. more efficient mastication) with resultant improved oral or overall health.⁵ The National Institute of Dental and Craniofacial Research, National Institutes of Health, cautions against treating the symptoms of TMD by altering occlusion and warns, 'Avoid treatments that cause permanent changes in the bite or jaw. Such treatments include crown and bridge work to balance the bite, orthodontics to change the bite, grinding down teeth to bring the bite into balance (occlusal adjustment), and repositioning splints, which permanently change the bite'.⁶

Acknowledgment of these previous misunderstandings in no way alters the fundamental objectives of orthodontic treatment nor does it diminish its value in improving quality of life and social wellbeing. What it calls into question are some of the most fervently held assumptions regarding the relationship of anatomical occlusion to oral function and oral health. Although the traditional concepts of 'functional occlusion' and 'balanced occlusion' in restorative and prosthetic dentistry have undoubted merit, in the natural dentition these terms are not only ambiguous but are largely misplaced. The true role of satisfactory proximal and occlusal contact of teeth in the natural dentition is to maintain balance within the organ system, that is, to ensure functional stability. In seeking occlusal stability in patients the orthodontist is faced with two considerations: first, the differentiation between malocclusions that are functionally stable and those that are functionally unstable. Anatomical posterior crossbites, for example, vary in functional stability. If, in a maxillary palatal crossbite the guiding cusps of the maxillary posterior teeth rest in the central fossae of mandibular posterior teeth, both occlusal function and tooth position may be quite stable, and orthodontic correction not indicated. On the other hand, conventional clinical wisdom is that any palatal crossbite that deflects the mandible on closure can be considered functionally unstable and therefore an indication for orthodontic treatment. In a maxillary buccal crossbite (scissors bite), at least some of the maxillary teeth are unopposed even if the patient shifts the mandible to one side. In Australian Aboriginals (who were renowned for their excellent occlusion and dental stability prior to the introduction of modern diets), such an arrangement (so-called W occlusion) is quite common and is compatible with normal masticatory function, oral health and stability. However, where a severe Class II, Class III, or deep bite malocclusion is functionally unstable because of the lack of coupling of anterior teeth and potential absence of antagonists for the terminal molars, there is a valid reason for treatment, though not necessarily a compelling reason in the absence of any concern by the patient about the psychosocial effects of impaired facial and dental appearance.

Secondly, understanding what aspects of occlusion are important in determining stability or relapse following orthodontic treatment. Will the establishment of inter-occlusal contacts between opposing teeth

stabilise their vertical position? Almost certainly, yes, because even the intermittent pressures that accompany swallowing and REM sleep seem adequate to control vertical tooth migration so that it is no faster than vertical ramal growth. Will the occlusion stabilise a crossbite correction in which the maxillary arch was greatly expanded posteriorly, or the position of maxillary incisors proclined excessively? Almost surely not, because light sustained force from stretched soft tissues will overcome the forces of occlusion of much shorter duration. Under the circumstances, perhaps the most simple and practical goal of orthodontics in regard to functional stability is the establishment of an effective occlusal platform to control eruption and vertical drift of teeth. In the anteroposterior and transverse dimensions, teeth must be placed entirely within the zone of equilibrium mediated by enveloping soft tissues. Thus individual teeth or segments of a dental arch in functionally unstable positions or relationships may, as a consequence, affect oral health adversely. This is what is implied in recognising the existence of functional stability or instability. Making the distinction is an essential element of orthodontic assessment, and most important in treatment planning.

When Angle proposed that the study of occlusion become the backbone of dental science no one could have anticipated the dramatic advances that would occur in the basic medical sciences and technology over the following century, including insistence on scientific evidence for the validity of such advances. Whereas Angle was limited almost entirely to mechanical explanations for all occlusal phenomena, we now have the advantage of advances in biological anthropology and the molecular biology of tooth-supporting structures to help elucidate some of the still inadequately understood aspects of clinical orthodontics. Today, although the mechanism for post-emergent tooth eruption is still incompletely understood, we know that the intermittent forces of occlusion cannot alone explain the relationship between occlusion and stability. The soft tissue equilibrium established by the tongue and lips, and the trans-septal fibre apparatus maintain stability of tooth positions. The flaw in Angle's belief about the role of cusps in chewing and stability is related to several critical evolutionary events.

Bonwill and Angle believed that cusps, intercuspatation and the gear-like arrangement of articulated teeth

were vital to their function. Their teleological reasoning was based on the idea that only the 'Divine Architect' could possibly be responsible for such magnificently designed machinery. Both believed that tooth cusps and fossae serve as mini mortars and pestles for the trituration of food. Angle posited that the secondary function of cusps is to serve as locator jigs for referencing the upper and lower teeth, thereby maintaining their stability. Bonwill was very conversant with Darwin's theory of evolution, which had been proposed 25 years before, but he was entirely unconvinced of its validity. Bonwill even published a paper in 1894 titled, 'What has dentistry to demonstrate against the hypothesis of organic evolution?'⁷

During the 20th century, remarkable advances in paleoanthropology shed light on how changes in diet and food preparation over a period of approximately 2 million years led to the adaptative changes of reduction in the size of jaws, teeth, mouth aperture and mouth volume in prehumans and humans. During this long evolutionary period, the invention and use of stone tools for slicing through animal carcasses facilitated the inception of man eating raw meat. The discovery of fire, and the invention of cooking by *Homo sapiens* over 250,000 years ago, markedly reduced the essential need for the masticatory apparatus for fitness and survival. Perhaps most of all, changes in diet and food preparation made eating and digestion more efficient, in turn effectively conserving energy.⁸ It has been suggested that the relatively recent introduction of eating utensils that is, the knife and fork will ultimately cause further diminution of the teeth and jaws of humans.⁹

In light of greater knowledge about the significance of these evolutionary events, we now recognise the serious flaws in Bonwill's and Angle's theories about the role of cusps in chewing in modern peoples. It is also clear from the fossil and skeletal record that by the Stone Age, humans had almost entirely worn the cusps off their posterior teeth through attrition by the time the permanent second molars erupted. Similarly the cusps of the second molars were entirely worn away by the time the third molars emerged. A similar observation in Australian Aborigines prompted Begg, who had been a student of Angle's, to speculate that the sole purpose of tooth cusps in modern man was to serve as referencing jigs for guiding teeth into occlusion during the development of the dentition.

Begg speculated that once teeth were in occlusion, cusps no longer served a meaningful function. He opined, 'Generally speaking, textbook ideal occlusion has been implicitly endowed with attributes in excess of reality'.¹⁰

Angle made a lasting contribution to dentistry by formalising the concept that the lifetime preservation of the natural dentition requires establishing proximal and occlusal contacts of teeth to foster stability and equilibrium within the functioning dentition, and achieving tooth positions, promoting balance in the relationship of the dentition to its investing soft tissue and musculature. This disarmingly simple, yet ultimately profound concept emphasising the critical importance of functional stability of the dentition, changed the future course of clinical dentistry. Tooth alignment and occlusion are important in maintaining the long-term function and appearance of the dentition, thus optimising social wellbeing and quality of life, even if ideal interdigitation of teeth does not prevent post-orthodontic relapse.

Perhaps Angle's most important contribution to clinical orthodontics was by providing the insight that the goals of treatment are to maintain or establish functional stability of the dentition, and to achieve balance between dentition and soft tissue drape, thereby enhancing dentofacial appearance.

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