The 100-year dilemma: what is a normal occlusion, and how is malocclusion classified?

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Orthodontic treatment cannot properly begin until the malocclusion is described. Angle's classification of malocclusion, developed a century ago, is still the subject of debate and controversy. A review of the literature is presented and the differing viewpoints are discussed. (Quintessence Int 1990;21:407-414.)

Introduction

Classification is a vital element in the diagnosis of a malocclusion and in treatment planning for orthodontic care. After countless numbers of individual malocclusions have been segregated into groups containing common factors, conclusions pertaining to etiology, prevention, proper mechanics, prognosis, and retention that aid the practitioner in resolving the problems can be made. Classification also facilitates communication between professionals since it provides dentists with a common descriptive language.

When two dentists discuss a patient's orthodontic problem, it is axiomatic that Angle's classification of malocclusion probably will be mentioned within the first sentence, or surely within the second. So pervasive is acceptance of Angle's classification, that, nearly a century after its introduction, it is virtually the only universally accepted classification of malocclusion. His concept, which has stood the test of time in the rapidly evolving profession of dentistry for 100 years, has been eminently useful — but is it precise?

The authors, as academicians and clinicians, have found it difficult to apply Angle's classification to the diversity of malocclusions seen in the population. We question the concept of Class I as a treatment goal. Are these concerns merely anecdotal, and based on personal biases, or have others also observed weaknesses in classification methods?

Etiology versus morphology

Basically, there are only two approaches to classifying a malocclusion. The first method considers etiology. Kingsley, in 1880, focused on causative factors in his pioneering work. However, since the etiology of a malocclusion is frequently multifactorial and often not discernible, his classification was not widely accepted.

By far, the preponderance of orthodontic classifications utilize morphology. Morphologic classifications are complicated by the wide variations found in human occlusions and anatomic forms, the variations in severity of malocclusions, and the frequent overlapping of numerous problems in a patient. Angle, in the 1890s, utilized the presumed constancy of the position of the maxillary first molar to develop a morphologic standard.

Angle's classification

In 1900 Angle stated, "The key to occlusion is the relative positions of the first molars. In normal occlusion the mesio-buccal cusp of the upper first molar is received in the buccal groove of the lower first molar.... The mesial incline of the upper cusp occludes with the distal incline of the lower cusp, the (cusp's) distal incline occluding with the mesial incline of the buccal cusp of the lower first bicuspid... and the distal incline of the distal cusp of the upper
first molar occluding with the mesial incline of the mesial cusp of the lower second molar. . . . It will thus be seen that each of the teeth in both jaws has two antagonists or supports in the opposite jaw, except the lower central and the upper third molar." (Fig 1).

In his 1900, sixth edition text, Angle defined Class II malocclusion as an abnormal mesiodistal relation of jaws and dental arches in which all mandibular teeth occlude distally to normal by the width of one bicuspid. Class III malocclusion was defined as an abnormal relation in which the mandible is positioned mesial to normal by the width of one bicuspid.

However, in 1907, when Angle published his seventh edition work, he made a significant modification in the definition of Class II and Class III malocclusions. Angle altered the amount of deviation from ideal Class I to either Class II or Class III malocclusion from "the width of a bicuspid" to "a deviation from ideal of more than one-half the width of one cusp."

Controversy

For a concept of occlusion that was destined to vanquish all others, Angle’s principles met with immediate criticism. Cryer, in 1904, took Angle to task for idealizing the straight white profile of an Apollo Belvedere (Fig 2), while selecting as his example of an ideal dentition Broomell’s “Old Glory” skull of a prognathic black male (Fig 3). These two ideals could never have coexisted in one individual. Cryer believed that, in contrast to Angle’s teachings, the outline of the face in all of its individual variations, the appearance of the teeth when the lips are open, and the importance of occlusion in regard to vocalization and mastication should all be considered. For these reasons, Cryer considered extraction of teeth as an acceptable solution to malocclusion, in direct contradiction to Angle’s strict prohibition against extraction for orthodontic purposes.

Case also criticized Angle’s belief that, when the dentures are placed in normal occlusion and the maxillary first molars are related properly to the cranium, the facial outline will take care of itself. Case said, "Failure to extract teeth where demanded [by facial profile considerations] is quite as much malpractice as the extraction of teeth where not demanded." Case made plaster masks of faces to illustrate facial types and esthetic concerns. He considered Angle’s classification imprecise. Case’s classification divides Class I into a division 1 with seven subtypes of dental irregularities and a division 2 for facial considerations. His Class II has a division 1 for cases in which the mandible is retrusive (with two subtypes) and a division 2 for cases in which the maxilla is protrusive (with four subtypes). His Class III has four divisions that describe combinations of maxillary retrusions and mandibular protrusions. That Angle’s classification remains the standard, while Case’s superior effort never became popular, was an unfortunate result of the personality cult that surrounded early orthodontic giants.

In 1915 Van Loon published criticism of Angle’s classification and proposed an improved technique for trimming plaster casts. He also oriented casts of teeth into plaster facial masks so that the true relationship of the teeth to the soft tissue of the face could be evaluated.

Dewey, an early student of Angle and then fellow teacher who philosophically parted company with his mentor, wrote in 1915, “I have great respect for the first molar as an organ of mastication, and they are
very necessary in producing normal occlusion, but as a basis of classification, when taken alone, I have not much respect for them, as they are as liable as any other teeth to assume an abnormal position under certain conditions.” Dewey recommended that classification be based on the anteroposterior relation of the arches as a whole rather than only the first molars. Dewey subclassified Class I into three types, and Anderson later added two more.

In 1920 Hellman stated, “In all its simplicity, the Angle classification does not convey exactly the same idea to everyone. This is, perhaps, due to the fact that its definition is not sufficiently accurate.” Hellman illustrated his contention with photographs of casts about which considerable difference of opinion could occur regarding their classification. Hellman studied comparative anatomy and the evolution of primitive landmarks of occlusion. He recommended elimination of the buccal cusp relationship as the focus of classification. The mesiolingual cusp of the maxillary first molar occludes in the central fossa of the mandibular molar. Hellman considered this lingual cusp to be the only reliable distinguishing feature, because it was the most primitive landmark of occlusion still retained by modern man. He observed in a high percentage of malocclusions that the maxillary first molar had rotated on the longitudinal axis of the lingual cusp, and the buccal cusps had rotated mesially. The mesially rotated maxillary buccal cusps falsely indicated a Class II occlusion, while the more “primitive” maxillary lingual cusp sat in its ideal Class I position.

What is normal and what is ideal?
Orthodontic practitioners wrestled with the practical and philosophical implications of the concept of ideal occlusion as a goal in treatment. Johnson, in a series of lectures delivered at the University of Pennsylvania and then published in 1923, pondered this conundrum. He asked, “What is normal occlusion? Does it [normal] mean an ideal, a goal to be sought after but never found?” If normal is synonymous with typical or average, can normal be taken as a standard because of a high frequency of occurrence? Or does normal mean natural? Some believed that teeth moved to normal occlusion will be stable. If normal is defined as according to, or not deviating from, an established norm, then norm is a rule or authoritative standard. Normal cannot be synonymous with ideal or natural.
Since perfection is not the rule in animal organization, Johnson14 discussed Hellman's concept of variation from normal. He agreed with Hellman that normal occlusion, as conceived by dentists to represent 100% perfection, was a myth.

Hellman15 felt that norms cannot be used as treatment goals, because the anatomic variation in size and shape of teeth among individuals is so large that norms cannot distinguish excellent occlusion from malocclusion.

Horowitz and Hixon1 considered normal, meaning typical or usual, not acceptable as a goal in treatment, because malocclusion is the most typically seen state. Ideal occlusion, being very rare in a population is, in truth, abnormal. Ideal occlusion is a theoretical model, a manufactured convenience, not a biologic reality or necessity.

**Further occlusion research**

Bennett16 was a precursor of Simon when, in 1912, he recommended classifying malocclusions in sagittal, transverse, and vertical planes of space. Bennett,16 an Englishman, developed a classification that also uses Class I, II, and III, but he divides malocclusions by etiology rather than morphology.

In the 1920s Simon17-19 of Berlin developed a gnathostatic system using an elaborate facebow and impression-orienting apparatus to create study casts that were cephalometrically oriented to the patient's orbital plane (a line drawn from orbitale perpendicular to Frankfort horizontal). According to Simon's law of the canine, the orbital plane is coincident with the distal third of the maxillary canines. Simon17-19 related the dentition to the cranium in three dimensions of space: the median sagittal plane (using the midpalatal raphe) at right angles to the Frankfort horizontal plane, and at right angles to the orbital plane. While advanced for his time, the complexity of the equipment and the precision required to produce accurately oriented study casts obviated ready acceptance of his gnathostatic models. Further research has proved Simon's law of the canine to be in error, but his concept of three-dimensional orientation of the dentition to the cranium was a forerunner of modern day gnathology.

In 1927 Friel20,21 published his stages of occlusion from 3 years of age to old age. He demonstrated not only numerous changes in the primary dentition, which Angle did not address, but also the variability of first molar position in a normal occlusion as it undergoes its metamorphosis from the transitional mixed dentition to the worn teeth of old age (Fig 4). Friel20,21 thus illustrated the difficulty of trying to force Angle's static ideal on a changing mechanism.
Angle answers critics

In 1928 Angle\textsuperscript{22} reiterated his belief that the maxillary first molar was the most reliable point of reference from which to compare other teeth, because of its constancy in taking correct position on eruption. However, Angle acknowledged that the first molars may erupt in modified positions when influenced by the malposition of other teeth, either primary or permanent, or by the loss or nondevelopment of teeth anterior to the first molars. Therefore, Angle recommended visualizing the first molars into their proper positions relative to the jugal buttress (key ridge) before classifying the malocclusion (Fig 5). Angle\textsuperscript{23} said, "Notwithstanding the efforts of the prejudiced and the superficially informed to disprove them, the first permanent molars are now and must continue to be recognized by all who know the growth, physiology and mechanics of the denture, as the chief reliance, not only as a basis for diagnosis, but also as a basis from which to note changes both favorable and unfavorable in the positions of the other teeth throughout the whole process of treatment and retention." Angle was not a man given to equivocation or timidity in presenting an inflexible position, even in the face of contrary evidence.

The debate continues

In 1938 Strang\textsuperscript{24} felt strongly that the process of classification should include inclined plane relationships, the axial inclination of each tooth, a frontal analysis of midline deviations and possible asymmetric condylar positions, rotations of posterior teeth, and facial and skeletal considerations using photographs and cephalometric radiographs. In effect, Strang\textsuperscript{25} advocated making a complete diagnosis, using all available records, before deciding on the true classification of a case, rather than basing classification on the dental occlusion alone. He believed that Angle’s reliance on the constancy of the maxillary first molars to the cranium led to unreliable classification results. Strang’s textbook\textsuperscript{24} gave elaborate examples of ten cases and his method for obtaining Angle’s classification. His directions required mentally repositioning the first molars to their “proper” location using determinations such as ideal axial positions of other teeth, especially canines. The fallacy in this technique, however, lies in the inconsistent application of subjective measures by different clinicians.

In 1939 Atkinson\textsuperscript{25} defended Angle’s hypothesis of a relationship between the maxillary first molar and the cranium. However, by showing that these relationships change with age and among different racial types, he neutralized Angle’s absolutist dogma.

In 1951 Massler\textsuperscript{26} remarked that, even when dentists are carefully trained, applying Angle’s classification meets with considerable subjective judgment and different results with different examiners.

In 1954 Stoller\textsuperscript{27} integrated concepts from Angle, Strang, and others. He observed that the mesiobuccal cusp of the maxillary first molar should ideally be slightly distal to the mandibular molar buccal groove, contrary to usual practice. Cases in which the maxillary mesiobuccal cusp fit exactly in the mandibular buccal groove did not exhibit proper interdigitation of the premolars and canines. Also, Stoller\textsuperscript{28} reiterated Strang’s observation that the maxillary first molar crown should be tipped mesially (or, expressed another way, that the roots tip distally) in ideal occlusion (Fig 6). This places the distobuccal cusp lower (more occlusally) than the mesiobuccal cusp. Therefore, the distobuccal cusp of the maxillary first molar should rest well down into the embrasure between the mandibular first and second molars. Stoller\textsuperscript{27} noted that, when the maxillary first molar is not tipped the maxillary premolars and canines mesh slightly mesial to the embrasures of the mandibular teeth. The maxillary
canine is, therefore, riding up on the mandibular canine, a situation that causes mandibular anterior collapse in postretention. In addition, Stoller thought that if the maxillary first molar, instead of proper buccal outset from the second premolar, is rotated mesiolingually so that its buccal cusps line up with the premolar, the maxillary molar occupies more space (because of its trapezoidal shape), and thereby causes an anterior positioning of all teeth mesial to the maxillary first molar.

Ricketts and others, working with Rocky Mountain Data Systems in the late 1960s, designed a computerized cephalometric analysis that classified malocclusions from a cephalometric radiograph rather than from casts. Measuring the distance along occlusal plane between the distal surfaces of the mandibular and maxillary molars, it was determined that in Class I the mandibular molar is 3 mm forward, in Class II the maxillary molar is forward of even, and in Class III the mandibular molar is more than 6 mm forward. Using the canines as an additional anteroposterior classification aid, they determined that in Class I the maxillary canine cusp tip is 2 mm distal to the mandibular canine cusp tip, in Class II the maxillary cusp tip is 1 mm or more forward, and in Class III the maxillary cusp tip is more than 5 mm distal to the mandibular cusp.

In 1969 Ackerman and Proffit acknowledging the limitations of Angle's classification, proposed a new classification scheme that combines five descriptive characteristics for malocclusions: alignment in occlusal view, profile and soft tissue, transverse plane deviations (crossbites), sagittal plane deviations (antero-posterior) using Angle's classification, and vertical problems of bite depth. The five characteristics can each be found alone or in overlapping combination for a total of nine classification groups. This classification lends itself to computerization.

In 1972 Andrews published six keys to normal occlusion. Molar relation was discussed in key 1. First, the distal surface of the distobuccal cusp of the maxillary first permanent molar should occlude with the mesial surface of the mesiobuccal cusp of the mandibular second molar. Second, the mesiobuccal cusp of the maxillary first molar should fall in the groove between the mesial and middle cusps of the mandibular first molar, as per Angle. Andrews thought that this relationship alone could be insufficient, because it is possible to have Angle's Class I and to have the maxillary second premolar not fit properly in the embrasure between the mandibular premolar and molar. Third, the mesiolingual cusp of the maxillary first molar must be seated in the central fossa of the mandibular first molar. Keys 2 through 6 also contain objectives that must be met for the occlusion to be considered correct.

In 1973 Arya et al published a paper that studied the relationship between the terminal plane of the sec-
ond primary molars and the subsequent occlusion of the permanent first molar. In cases in which the permanent first molars erupted initially into cusp to cusp occlusion, 70% became Class I and the remainder eventually became Class II. Because of the inconsistency of molar occlusion over time in an individual, a classification technique that helps bridge the transition from primary through permanent dentition is needed.

Graber and Swain noted that Angle’s classification fails to separate malocclusions with analogous anteroposterior relationships but with other characteristics that are dissimilar and thus require different treatment plans. They warned that the tendency to treat malocclusions of the same classification in a similar manner is detrimental to patients who do not have homologous malocclusions.

Integrating occlusion to physiology

Graber stressed that modern concepts of normal occlusion require three main areas of health: the occlusal position of teeth in contact, in harmony with the postural resting position as determined by the musculature, and the temporomandibular joint morphology. A fourth element could be added: the anteroposterior development of the maxilla and mandible. Each of these elements must be healthy, individually and in combination, for optimal function and comfort.

Roth stated that form and function are not always coincidental. Excellent occlusion and morphologic form may not always be in harmony with the temporomandibular joints. The patient’s neuromuscular protective mechanism could cause him or her to avoid occluding when interferences are present in the patient’s terminal hinge centric relation path of closure as dictated by the temporomandibular joint. To avoid contacting interferences, the mandible slides into a maximal intercuspation, which looks beautiful in a hand-held set of plaster casts. Unfortunately, the condyles have translated away from the healthy centric relation position (condyle most centered and superior) into an unhealthy position, with the condyles in their fossae. When the discrepancy between the dictates of the joint and the dictates of occlusion becomes too great, muscles go into spasm and it becomes virtually impossible to find the ideal path of closure and the offending occlusal interferences. Roth’s criteria for a good functional occlusion include proper condylar and disk position upon closure and movement, even occlusal contact bilaterally, holding centric contacts, harmonious anterior guidance, and posterior clearance on excursions.

Elsasser published a numeric classification in 1978. Using millimeter measurements of incisal overbite, overjet, maxillary midline, mandibular midline, right canine, left canine, right first molar (mesiodistal), right first molar (buccolingual), left first molar (mesiodistal), and left first molar (buccolingual), he developed a ten-number classification. A patient’s malocclusion is compared to the ideal goal of 2200-00-0202.

The enormous challenge involved in developing a classification method that is “all inclusive” has, so far, defeated dentistry’s greatest minds.

The present and the future

Roth recommends centric relation recording techniques in conjunction with fully adjustable articulators and detailed facebow transfer methods to obtain mounted casts that are properly related to the joints. Clinicians of the 1990s find no fault with the veracity of his recommendations. However, for many practitioners, economics and the demands of the marketplace make adherence to Roth’s complex methodology difficult to follow for routine orthodontic treatment. The challenge of developing more simplified systems for establishing accurate recording of occlusion—temporomandibular joint interrelationships may rest with the next generation of dentists.

Koski wrote concerning the difficulty of establishing a diagnostic norm for the dentition, as well as a therapeutic norm to serve as a basis for treatment. But Koski optimistically noted, “However, the general orderliness of nature (naturally allowing for common variations) and the rather close structural-functional synchronization of the different parts of an organism seem to suggest that there may exist certain basic regularities or norms also within the dento-facial complex, which might be discovered through more systematic and diversified effort than heretofore.”

We witness at the end of the twentieth century the recent return of the personality cult and the dogma of absolutist extraction theory that plagued the early twentieth century, with Angle against his peers. History has a way of coming full circle.

One hundred years of occlusion research has ended. What advances can we expect in the next century? The search continues.
References


