Centric relation treatment and articulator mountings in orthodontics

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In an article published recently in the *American Journal of Orthodontics and Dentofacial Orthopedics*,[1] I outlined the steps I believe orthodontists must take if we are to succeed as a specialty:

1. Specific, comprehensive, universal treatment goals must be developed.
2. Occlusion, TM joint function, facial esthetics, and periodontics must receive greater emphasis in our graduate training courses.
3. The quality of orthodontic records must be upgraded.
4. A comprehensive orthodontic classification system must be developed.
5. Orthodontic diagnosis must become more accurate.
5. Orthodontic treatment time must be minimized.

I did not discuss two significant issues in that article that many dental practitioners feel are the most important in contemporary dentistry: centric relation as a treatment goal and articulator mountings in orthodontics. These issues are important for two reasons. First, they will form the basis of the third great debate in orthodontics (the first two being extraction versus nonextraction treatment and functional versus fixed treatment.). Second, these two issues comprise the foundation for state-of-the-art orthodontic treatment in the 21st century, which will include the following:

1. Use of a repositioning splint to eliminate MPD symptoms and attain a comfortable, stable, centric relation jaw position.
2. Instrumental analysis of diagnostic study models—mounting diagnostic study models in centric relation on a semi-adjustable articulator using at least an estimated facebow transfer.
3. Measurements of jaw deflections caused by tooth-dictated positions (currently measurable with CPI (Panadent), MPI (SAM), and CMP (Denar) instrumentation).
4. Computer-assisted treatment planning, including: (a) corrected cephalometrics (CO to CR conversion of lateral cephalograms); (b) computerized cephalometric analyses corrected for jaw deflections; (c) computerized growth determinations; (d) computer-aided treatment forecast (VTOs).
5. Video imaging as an aid to optimizing dental, skeletal, and soft tissue esthetics.

Before addressing these issues, we must first address the issue of treatment goals in orthodontics. The long-held goals in dentistry of stability, health, esthetics, and function also apply in orthodontics. Orthodontic treatment goals can be further divided into facial, skeletal, dental, and functional parameters. For the sake of this discussion, we will focus on dental and functional relationships. In their text, *Occlusion and Malocclusion*, Howat, Capp, and Barrett[2] stated, "Orthodontic assessment of patients has evolved as treatment goals have changed." In 1972, Andrews, in the "Six Keys of Normal Occlu-

sion,"[3] proposed static occlusal goals for orthodontic treatment, thus providing a guideline for the exact positioning of each tooth in all three planes of space. Roth[4,5] later added keys which relate to occlusal function and the orthodontic treatment mechanics that make it possible to attain gnathologic treatment goals orthodontically. Thus, each has pioneered a path toward the standardization of orthodontic occlusal treatment goals.

This leads to the discussion of a fundamental aspect of orthodontic correction: the need for coordination of tooth position with jaw function. Since the beginning of the orthodontic specialty, some clinicians have mistakenly treated these essential elements as separate entities. Yet the issue of functional occlusion has been with the profession for at least 40 years. In 1956, Thompson[6] titled his article, "Function—the neglected phase of orthodontics," and stated that "Excellent (static) occlusal relationships have been assumed to provide excellent function, but this is not true." In 1975 Perry[7] stated that "The orthodontist has the opportunity and responsibility to provide the most comprehensive enhancement of oral function. For too long we have based our treatment results upon plaster cast changes. We must realize that we are now obliged to evaluate our results in terms of movements of the mandible over the entire functional gamut of the stomatognathic system."

These words were written 20 years ago, and although Andrews,[3] Roth,[5] Williamson,[8-10] Stuart[11,12] and others[2,13-17] have outlined practical techniques for accomplishing these goals, the specialty has been inexplicably slow in adopting them.

There is, however, a movement from both inside and outside the specialty that emphasizes the importance of harmonizing the occlusion with the patient's mandibular movements. Howat, Capp, and Barrett[2] wrote that "Knowledge of mandibular movements and positions is essential for the clinician, whether the occlusion of one tooth or an entire arch is being altered. Changes in the occlusion produced by orthodontics or restorative dentistry should be in harmony with the mandibular movements so that minimal adaptation is required from the patient's neuromuscular system. Orthodontic treatment may produce a functionally acceptable occlusion only if teeth are moved into positions which accommodate and do not interfere with mandibular movements."

If one accepts the treatment goal of coordinated tooth and jaw function, then diagnosing from and treating toward centric relation mandibular position is of paramount importance. Orthodontics provides the ability to move every tooth in all three planes of space, making orthodontic treatment comparable to full mouth reconstruction or a complete denture setup. Thus, in ortho-dontics, it is imperative to have a stable, comfortable, repeatable jaw position to work from. Bennett and McLaughlin[18] stated that "It is generally accepted that a seated and concentric condyle position is the most beneficial position to establish during orthodontic treatment," while Alexander[19] stated that centric relation is considered the most reliable reference point for measuring the relationship of the mandible to the maxilla. Howat, Capp, and Barrett,[2] Ramfjord and Ash,[20] and others[21,22] held that approximately 90% of the population have a discrepancy between the seated contact position (seated CP)/centric relation jaw position and the intercuspal position (ICP/maximum intercuspation (MIC)/centric occlusion jaw position. (Historically, centric relation jaw position has been defined as the most "retruded" contact position, but current research indicates that the correct definition is "the relationship of the mandible to the cranium that exists when the condyles articulate with the thinnest avascular portion of their respective discs in their most anterior-superior position against the slopes of the articular eminences, regardless of tooth contact. Centric occlusion jaw position is defined as the most closed position that the mandible assumes, determined by the full intercuspation of opposing teeth, irrespective of condylar position.[23]) This is important because non-coincidence of seated CP/CR and MIC/CO can result in both occlusal interferences on all teeth in every plane of space and mandibular displacements on closing in all directions (anterior-posterior, vertical, and transverse). The significance of this lies in the fact that the patient's neuromuscular system may habitually guide the mandible away from interferences/occlusal prematurities, making their detection difficult. Thus the practitioner cannot trust the occlusion observed in the mouth.[2,4,5,8,10,13-15,24-35] The discrepancy/slide between CR and MIC/CO needs to be identified and eliminated when reorganizing the occlusion, which is required: (1) when restoring posterior occlusal stability by occlusal adjustment or tooth restoration; (2) when treating mandibular dysfunction; (3) prior to multi-unit restorations; (4) prior to complete denture prosthetics; (5) when treat-

ing a patient orthodontically; or (6) when positioning the condyle during orthognathic surgery.

Identification of the discrepancy/slide is best done with diagnostic study models mounted in centric relation on a semi-adjustable articulator using at least an estimated facebow transfer. The amount (mm) and direction (horizontal, vertical, and transverse dimension) of any discrepancy between CR and MIC/CO can be determined with ease through the use of condylar position instrumentation available today (for example, the Panadent CPI, SAM MPI, or Denar CMP instruments). (Corrected tomograms may also be used to determine condylar shape and approximate condylar position, but they are not as accurate as the millimeter measurements that are possible with the condylar position instrumentation.)

As Alexander's research shows, this instrumentation provides an extremely accurate representation of the spatial relationships that exist within the TM joint.[19] This is of great diagnostic value because it helps to establish more clearly in which direction tooth movements must be made to achieve CR-MIC/CO coincidence.

There are a number of reasons orthodontic study models mounted in centric relation are a must in today's orthodontic arena. First and foremost is the opportunity for improved diagnostic accuracy prior to treatment. We diagnose only what we see. If diagnostic study models are not mounted in centric relation, then some problems may be missed. A classic example of this is the diagnostic dilemma of the dual bite.[36] As orthodontists are well aware, a potentially significant problem awaits any practitioner (orthodontist or otherwise) who places bands and/or brackets on the teeth: the presence of a dual bite. Some patients have hidden skeletal problems that must be detected at the diagnostic stage. By definition, it is now apparent that a dual bite is the difference in condylar position between ICP/MIC/CO and seated CP/CR. This is why mounting diagnostic study models is so important: current instrumentation allows the practitioner to determine the amount and direction of the discrepancy between centric relation condylar position and centric occlusion condylar position pretreatment. Traditionally, dual bites have been viewed as pre-existing conditions that may preclude an accurate skeletal and occlusal pattern from being identified. This is the case if diagnostic study models are hand-held and trimmed to MIC/CO. However, the inability to diagnose a dual bite through traditional orthodontic means is often viewed by patients as an avoidable problem. Practitioners who routinely mount their pretreatment and post-treatment study models agree. A dual bite is not just a pre-existing condition—it is one that can be routinely diagnosed, just as Angle classification, overjet, and overbite can be diagnosed using the proper techniques and instruments. The phenomenon of dual bite clearly indicates the limitations of traditional orthodontic records, the far-reaching ramifications of the lack of accuracy of traditional orthodontic diagnosis, and the need for more accurate orthodontic treatment planning.

A significant number of practitioners[1,3,4,5,8-15,25,37-39] have, for years, advocated mounting orthodontic study models in centric relation. These practitioners, along with recent orthodontic texts,[2,3,11,18] state that it is not an optional step to be taken on some patients, but a necessary step to be taken on all patients, whether young or adult, because it is not possible to accurately predict which cases need to be mounted. Unfortunately, the mouth is not an accurate articulator.[2-4,11-13,15,24,26,27,40] Many patients have accommodated, through various mechanisms, to all varieties of dentofacial problems. These accommodations occur because patients' neuromuscular systems guide them into closure where the teeth fit together best, as the muscles of mastication adapt to proprioceptive prematurities. Frequently these accommodations mask the true nature or full extent of the problem. Only an accurate diagnostic mounting of study models from a comfortable, stable, repeatable mandibular position will consistently reveal the true skeletal and dental relationships. According to Howat, Capp, and Barrett,[2] "A semi-adjustable articulator is the instrument of choice for diagnosis and treatment planning in both orthodontics and complete denture prosthetics. The use of an articulator is important, as inadequate diagnostic information may be obtained from hand-held models trimmed in MIC/CO or a clinical exam alone." [2]

Bite disharmonies cannot be studied (or even detected in most cases) in the functioning mouth because the muscles and nerve reflexes protect the teeth by overriding the joint's guidance.[41,42] Centric relation records allow the joint and tooth relationships to be studied without interferences from muscles and nerve reflexes. Centric relation records consist of:

1. Models of both upper and lower dental arches;
2. A centric relation bite registration to record the relationship between the upper and lower teeth when the condyle is seated in the fossa; and
3. A record of the axis of rotation of the condyle in relation to the upper teeth, made with either an estimated facebow transfer or a true hinge axis transfer.

When these records are properly transferred to an articulator, the relationships between the teeth and jaws can be studied accurately. The mandibular cast must be mounted at a point on the seated condylar axis before first tooth contact occurs, using an interocclusal record to relate it to the maxillary cast. This is necessary to prevent a centric prematurity from deflecting the mandible upon closure, which in turn allows for diagnosis of the problems, planning of treatment, prediction of results, and occlusal finishing at the end of treatment that is not possible with hand-held models trimmed in MIC/CO.

The number of "easy" cases seen by orthodontic specialists is dwindling at a slow but steady rate. And the chance of missing important diagnostic information increases dramatically by using hand-held study models trimmed in MIC/CO. Dual bite cases, asymmetries, and surgery cases are not as clearly evident as our orthodontic graduate students have been led to believe. Roth[4, 5] believes that 15% of all asymptomatic teenage patients have a significant CR-CO discrepancy, while Williamson[8,10] has shown that 33% of adolescents presenting for routine orthodontic care already have incipient symptoms of masticatory muscle dysfunction. These percentages are much higher in adult patients. Unfortunately, it is not possible for practitioners, even those who routinely mount their cases, to accurately diagnose these conditions 100% of the time. Although certain signs may be indicative of the presence of a dual bite, such as wear facets, difficulty in manipulating the mandible, and masticatory muscle tenderness/tightness, detailed occlusal analysis requires mounted diagnostic casts. As Vince Lombardi stated in his philosophy of football, "There are only two or three plays a game that will determine the difference between winning and losing. I'm sorry, but I can't tell you which ones they'll be. You have to play them all 100%."

Imagine for a moment how many diagnostic problems could have been avoided if the pretreatment records had been more accurate. Every orthodontist has a number of cases in his or her practice that could have benefitted from a diagnostic mounting in centric relation. If the percentages quoted by Roth and Williamson regarding the number of significant CR-CO discrepancies present pretreatment are accurate, then out of every 100 cases started, 15 or so may represent potential problems. It only makes sense to implement a practice that might cut down on the number of diagnostic problems.

A diagnostic mounting is essential, whether the occlusion of one tooth or an entire arch is being altered, for the following reasons:

1. To eliminate the patient's neuromuscular response to the occlusion;
2. To study and measure condylar position and movement in three planes of space (AP, vertical, transverse);
3. To study the fulcrum points/first premature occlusal contacts;
4. To correct the lateral cephalogram from CO to CR;
5. To determine the correct soft tissue relationship (with mandible in CR);
6. For splint construction;
7. To evaluate the arc of mandibular closure;
8. For presurgical evaluation and surgical splint fabrication;
9. For fabrication of a gnathological setup and tooth positioner;
10. For trial treatment, to determine what can be accomplished before working on the patient and to test the accuracy of occlusal alteration,
11. To evaluate the finished result;
12. To perform an accurate equilibration;
13. For medicolegal documentation.

A significant number of practitioners pass judgment on the efficacy of these techniques without having tried them in their own practices. Yet, if dentofacial orthopedics is to be included in the description of the specialty of orthodontics, knowledge of both tooth position and jaw position is required. Hand-held models are inadequate for assessing these parameters. To the critics of this fundamental treatment approach, I have this to say: If you are not familiar with these techniques or instrumentation or if you have not tried them in your own practice on a daily basis, then you are in no position to judge their effectiveness. It is one thing to master these techniques and then discard them as not useful. It is quite another to criticize them without understanding the philosophy or actually experiencing the techniques.

Where do TMD and repositioning splint use fit into this discussion? Although TMD most likely has a multifactorial origin, completely discounting the role of occlusion may be an inappropri-

ate interpretation of published data.[7,9,13,25,43-48] There is evidence that nonworking/balancing interferences may lead to muscle hyperactivity in susceptible patients, which may cause bruxing, clenching, and TMD symptoms.[2,7,25,43-45,49]

Many practitioners[1-5,8-15,24-27,37-39,40] believe that restorative dentistry and orthodontics should not be undertaken in patients suffering from dysfunction of the muscles of mastication and TM joints, as it is impossible to locate a stable, comfortable, repeatable jaw position in these patients and it is impossible for these patients to perform normal, smooth, reproducible mandibular movements.[11,12,40,50] Repositioning splint wear is used both therapeutically (to alleviate symptoms through muscle relaxation) and diagnostically (to attain a stable, comfortable, repeatable jaw position and a normal range of reproducible mandibular movement through condylar repositioning/seating). In this way, an accurate centric relation bite registration/interocclusal record can be taken for diagnostic cast mounting and the true hinge axis can be located and transferred, if necessary. Splint wear prior to restorative dentistry and orthodontics is indicated when:

1. The patient exhibits signs and symptoms of TMD;
2. Difficulty is experienced in recording RCP/CR;
3. As a routine, prior to full mouth reconstruction orthodontics, and orthognathic surgical procedures;
4. The patient cannot perform reproducible pantographic tracings/mandibular movements.

Splint wear is continued until:

1. Signs and symptoms of TMD have been alleviated;
2. A stable, comfortable, repeatable jaw position has been achieved (as evidenced by stable occlusal contacts on the splint for three months);
3. The patient can perform reproducible pantographic tracings/mandibular movements.[1,2,4,5, 8,10-13,24,26,27,40,51] A repositioning splint can be used to locate the centric relation position of the condyles, to test the stability of the joints, and to test the patient's response to occlusal change.

Thus, a repositioning splint is an extremely valuable yet conservative appliance that aids in the therapeutic, diagnostic, and treatment planning phases of orthodontic correction.

In conclusion, it has been shown in all areas of dentistry that centric relation jaw position is the most stable, comfortable, repeatable condylar position from which extensive restoration of the dentition should be diagnosed and treatment planned. From the fixed prosthodontist restoring several quadrants at a time, to the removable prosthodontist fabricating complete dentures, to the oral surgeon positioning the mandible and condyle during orthognathic surgery, the common thread is the determination and attainment of a concentric, stable, repeatable condylar position. It is time for the specialty of orthodontics to accept this standard as a treatment goal and to embrace the instrumentation that makes assessment of this position possible. These techniques are simple and predictable and have proven to be faster, easier, less expensive, and more accurate than traditional orthodontic diagnostic techniques. These will be the next great issues in the specialty of orthodontics as we approach the year 2000—the future of orthodontic diagnosis and treatment planning is just around the corner. It is time for us to have the foresight to see the future today.

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References

1. Cordray FE. A crisis in orthodontics? It's time to look within. Am J Orthod Dentofac Orthop 1992;101:472-76.
2. Howat AP, Capp NJ, Barrett NVJ. Occlusion and malocclusion. St. Louis: C.V. Mosby, 1991.
3. Andrews LF. Straight wire. The concept and appliance. San Diego: L.A. Wells Co., 1989.
4. Roth RH. The maintenance system and occlusal dynamics. Dent Clin N Am 1976;20:761-88.
5. Roth RH. Functional occlusion for the orthodontist. J Clin Orthod 1981;15:1-80.
6. Thompson JR. Function—the neglected phase of orthodontics. Angle Orthod 1956;26:129-143.
7. Perry HT. Mandibular function: an orthodontic responsibility. Am J Orthod 1975;67:317-23.
8. Williamson EH. Orthodontic implications in diagnosis, prevention, and treatment of TMJ dysfunction. In: Graber TM, Swain BF, editors. Orthodontics: current principles and techniques. St. Louis: C.V. Mosby, 1984.
10. Williamson EH. The role of cranio-mandibular dysfunction in orthodontic diagnosis and treatment planning. Dent Clin North Am 1983;27:541-60.

9. Williamson EH. Occlusion and TMJ dysfunction. J Clin Orthod 1981;15:333-50.
11. Stuart CE. Good occlusion for natural teeth. J. Prosth Dent 1964;14:716-24.
12. Stuart CE, Golden IB. The history of gnathology. Ventura, Calif.: Stuart CE. Gnathological instuments, 1984.
13. Huffman RW, Regenos JW. Principles of occlusion. Columbus, Ohio: Hand R. Press, 1978.
14. Viazis AD. Atlas of orthodontics: principles and clinical applications. Philadelphia: WB Saunders, 1993.
15. Slavicek R. Clinical and instrumental functional analysis for diagnosis and treatment planning, part IV: instrumental analysis of mandibular casts using the mandibular position indicator. J Clin Orthod 1988;22:566-75.
16. McNeill C, et al. Craniomandibular disorders—the state of the art. J Prosth Dent 1980;44:434-37.
17. McNeill C. Craniomandibular disorders—the state of the art, part II. J Prosth Dent 1983;49:393-97.
18. Bennett JC, McLaughlin RP. Orthodontic treatment mechanics and the preadjusted appliance. Aylesbury, England: Wolfe Publishing, 1993.
19. Alexander SR, Moore RN, DuBois LM. Mandibular condyle position: comparison of articulator mountings and magnetic resonance imaging. Am J Orthod Dentofac Orthop 1993;104:230-9.
20. Ramfjord SP, Ash MM, editors. Occlusion: 3rd edition. Philadelphia: WB Saunders, 1983.
21. Ingervall B. Tooth contacts on the functional and non-functional side in children and young adults. Arch Oral Biol 1972;17:191.
22. Agerberg G, Sandstrom R. Frequency of occlusal interferences: a clinical study in teenagers and young adults. J Prosth Dent 1988;59:212.
23. Academy of Denture Prosthetics. Glossary of prosthodontic terms. J Prosthet Dent 1987;58:717-62.
24. Coulson R. Should the phenomena of muscle splinting be ruled out prior to making an orthodontic diagnosis? AAO Convention, St. Louis;1992.
25. Roth RH. Tempromandibular pain-dysfunction and occlusal relationships. Angle Orthod 1973;43:136-53.
26. Beard CC, Clayton JA. Effects of occlusal splint therapy on TMJ dysfunction. J Proth Dent 1980;44:324.
27. Capp NJ. Temporomandibular joint dysfunction—its relevance to restorative dentistry, part I. Rest Dent 1986;2:36.
28. Rieder CE. The prevalence and magnitude of mandibular displacement in a survey population. J Prosth Dent 1976;35:299.
29. Mohlin B, Kopp S. A clinical study on the relationship between malocclusions, occlusal interferences, and mandibular pain and dysfunction. Swed Dent J 1978;2:105.
30. Solberg WK, Woo MW, Houston JB. Prevalence of mandibular dysfunction in young adults. JADA 1979;98:25.
31. Maruyama T, Miauchi S, Umiekoji E. Analysis of the mandibular relationship of TMJ dysfunction patients using the mandibular kinesiograph. J Oral Rehab 1982;9:217.
32. Drowkas B, Lindee C, Carlsson GE. Relationship between occlusal factors and signs and symptoms of mandibular dysfunction. J Prosth Dent 1985;53:402.
33. Lederman KH, Clayton JA. Patients with restored occlusions. Part I: TMJ dysfunction determined by a pantographic reproducability index. J Prosth Dent 1982;47:198.
34. de Laat A., van Steenberghe D. Occlusal relationships and TMJ dysfunction. Part I: epidemiological findings. J Prosth Dent 1985;54:835.
35. Wong B., Roth R. Unpublished data. Personal communication 1994.
36. Marbach JJ. Phantom bite. Am J Orthod 1976;70:190.
37. Roth RH. Functional occlusion for the orthodontist, part III. J Clin Orthod 1981;15:174-98.
38. Williamson EH, Steinke RM, Morse PK, Swift TR. Centric relation: a comparison of muscle-determined position and operator guidance. Am J Orthod 1980;77:133-45.
39. Parker WS. Centric relation and centric occlusion—an orthodontic responsibility. Am J Orthod 1978;74:481-500.
40. Shields JM, Clayton JA, Sindledecker LD. Using pantographic tracings to detect TMJ and muscle dysfunctions. J Prosth Dent 1978;39:80.
41. Koveleski WC, DeBoeuer J. Influence of occlusal splints on jaw position and musculature in patients with TMJ dysfunction. J Prosth Dent 1975;33:321-27.
42. Capp NJ, Clayton JA. A technic for evaluation of centric relation tooth contacts: part II: following use of an occlusal splint for treatment of TMJ dysfunction. S Prosth Dent 1985;54:697-705.
43. Thompson JR. Abnormal function of the temporomandibular joints and related musculature: orthodontic implications, part I. Angle Orthod 1986;56:143-63.
44. Morawa AP, Loos PJ, Easton JW. Temporomandibular joint dysfunction in children and adolescents: incidence, diagnosis, and treatment. Quintessence Int 1985;11:771-7.
45. McLaughlin RP. Malocclusion and the temporomandibular joint: an historical perspective. Angle Orthod 1988;58:185-91.
46. Mohlin B. Prevalence of mandibular dysfunction and relation between malocclusion and mandibular dysfunction in a group of women in Sweden. Eur J Orthod 1983;4:115-23.
47. Mohlin B, Ingervall B, Thilander B. Relation between malocclusion and mandibular dysfunction in Swedish men. Eur J Orthod 1980;2:229-38.
48. Perry HT. Relation of occlusion to temporomandibular joint dysfunction: the orthodontic viewpoint. J Am Dent Assoc 1969;79:137-41.
49. Colquith T. The sleep-wear syndrome. J Prosth Dent 1987;57:33-41.
50. Kantor ME, Silverman SI, Garfinkel L. Centric relation recording technics—a comparative investigation. J Prosth Dent 1972;28:593.
51. Okeson JP. Fundamentals of occlusion and temporomandibular disorders. St. Louis: CV Mosby, 1985.