

REVIEW

Centric relation critically revisited—What are the clinical implications?

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Abstract

Purpose of the article: Centric relation is a dental term that has undergone many alterations over the years, which in turn have led to significant clinical controversies. These continuing changes in the meaning of the term CR have not only led to confusion, but they also have resulted in a variety of unnecessary diagnostic and therapeutic procedures. Analysis of the dental literature reveals ongoing misunderstanding and disagreement regarding that term among both clinicians and academic dentists.

Materials and methods: A search of the PubMed database was performed with the following search terms: “centric relation”, “masticatory muscles”, “maxillomandibular relationship” and “condylar position.” Relevant literature from the past 70 years until the present day was meticulously scrutinised.

Results: As expected, the literature review on the topic of CR revealed a problematic pattern of changing definitions and clinical disagreements, all of which have had a significant impact on the practice of dentistry.

Conclusion: There are semantic, conceptual and practical reasons for concluding that the term ‘centric relation’ is flawed. Those flaws have a significant impact on dental practice. Based on our analysis, argumentation is provided to conclude that the term ‘centric relation’ should be abandoned. Instead, it appears that every individual has a unique temporomandibular joint relationship which cannot be described by any singular term. In healthy dentate patients, this relationship is determined by the maximum intercuspation of the teeth and should therefore be considered as biologically acceptable.

KEYWORDS

centric relation, condylar position, maximum intercuspation

1 | INTRODUCTION

Determination and recording of the maxillomandibular relationship is a clinical procedure that may need to be performed in the dental office. There are two components of this relationship:

1. How are the upper and lower teeth meeting upon full closure of the jaw?
2. How are the mandibular condyles meeting the skull at that moment, often described as the temporomandibular joint or condyle/fossa relationship?

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In those clinical situations where such a recording is desired, which will be discussed below, the observed mandibular position will be judged as good if it is reproducible for both the clinician and the patient, while also being physiologically acceptable and comfortable for the patient.

Regarding the dental component, the maximal intercuspal position (MIP) of upper and lower teeth plays a crucial role. It has been defined in the current ninth edition of the Glossary of Prosthodontic Terms (GPT-9)¹ as 'the complete intercuspatation of the opposing teeth independent of condylar position'. In the vast majority of dentate patients, MIP is a stable and clinically reproducible position and it is both physiologically acceptable and comfortable for those patients; this dental relationship determines where the condyles will be located when the jaw is closed. That condyle position should therefore be considered a basic position for routine dental therapy in patients which does not need to be analysed or changed.²

Regarding the condyle-fossa relationship, the concept of centric relation (CR) was introduced into the dental literature almost 100 years ago^{3,4} to describe how these structures should meet, independent of the dental relationship. The term 'CR' (with its prescriptive component) has contributed to a lot of confusion within the dental community over decades. It was historically applied in two different contexts:

- The most obvious one was to define a so-called 'ideal' or 'optimal' intermaxillary reference position for patients who have lost posterior support and no longer have a stable and reproducible MIP. Hence, they will need major dental prostheses such as partial or full dentures. On the other hand, there are dentate patients who need major dental interventions, for example for extensive restorative dentistry or for orthodontic/orthognathic therapy,^{5,6} and they also will need to have a new condyle-fossa relationship established. Clearly, finding a new condylar position is a reasonable and necessary component to accomplish those major dental procedures.
- In subsequent years, however, the concept of CR also has been used to 'examine' dentate patients who presented for routine dental check-up evaluations. During that examination, the observed condylar position in CR was compared with the jaw relationship as determined by the patient's MIP. Differences between the patient-specific condylar position in MIP and the condylar position defined as CR were labelled as 'CR-MIP' discrepancies, also named centric slide, often associated with a negative connotation. Yet, these so-called discrepancies are found within the vast majority of the normal population, which strongly suggests that they are a normal feature of intermaxillary relationships.

Many methods to determine and transfer CR have been studied and proposed over the decades, almost all for individuals without pain and dysfunction in the masticatory system.⁷⁻¹⁰ It is interesting to note that only one study examined both TMD patients and healthy individuals using two versions of CR, by comparing the

musculoskeletally reproducible CR with the chinpoint-guided CR position.¹¹ This particular study was designed to assess measurement reliability using these two CR techniques, in order to determine whether the same centric relation position can be obtained with both methods. The null hypothesis was that there would be no differences between the obtained centric relation positions, in healthy individuals as well as in TMD patients prior to and after stabilisation splint treatment. The outcome was that for patients with a TMD diagnosis, the chinpoint-guided position differs from the stable orthopaedic position at baseline of splint treatment. However, there was coincidence of these two CR positions at the conclusion of treatment.

2 | HOW IS THE ORTHODONTIC PROFESSION IMPACTED BY THE CONCEPT OF CENTRIC RELATION?

The orthodontic profession has always had to deal with the question of post-treatment stability. This includes both dental occlusion considerations and concerns about how the condyle and disc should be positioned in relation to the fossa. For many years, the former issue dominated the discussions about post-therapy stability, while the latter issue was often not specifically addressed. For example, the classic articles by Angle^{12,13} and Andrews¹⁴ on finishing orthodontic cases to an optimal static occlusion do not include condyle-to-skull relationships on the list. Even the American Board of Orthodontics (ABO) guidelines¹⁵ describe finishing cases in terms of having the teeth in each arch lining up properly in terms of aesthetics and function, with the roots being parallel and the marginal ridges being even, but with no specific mention of a condyle-fossa relationship.

However, as early as the 1970s a movement arose within the orthodontic field in the United States to adopt the principles of gnathology (as espoused within the prosthodontic specialty) and apply them to orthodontic treatment. Spearheaded by authors like Roth,¹⁶ Cordray,¹⁷ and Kulbersh,¹⁸ it was claimed that failure to finish cases in CR would lead to increased risk for developing TMD problems. This movement caught on in some circles within the profession, and over time that philosophy was spread to other countries. During that same period, some individual orthodontists were taking continuing education at various 'occlusion institutes' where a similar viewpoint was being taught. As a result, there was a division within the field about adopting gnathological procedures as an essential component of orthodontic therapy. This was exacerbated by external pressure from some of their referring dentists who believed in gnathological theories and demanded such treatment from the specialists they were working with.

Authors like Rinchuse and Kandasamy,¹⁹ Gianelly,²⁰ Beattie,²¹ Michelotti,²² and Manfredini²³ were instrumental in challenging these viewpoints, and most of the orthodontic post-graduate programmes continued to follow a more traditional path of concentrating primarily on finishing of the dental relationships. While nearly everyone agreed that their cases should be finished with the TMJs

in a reproducible and comfortable position, those programmes in general did not buy into the gnathological paradigm. In this paper, the implications of this controversy will be considered as part of our general criticism of CR and our proposals for a new perspective regarding how the condyle and disc should be related to the skull.

3 | CHANGING DEFINITIONS OF 'CR' AND THEIR IMPACT ON CLINICAL PRACTICE

After the release of the latest edition of the GPT-9¹ and a survey among the Fellows of the Academy of Prosthodontics which attempted to limit the various definitions of the term CR to one single definition,²⁴ several articles have been published presenting diverse views on the concept of CR. Among them were:

- a discourse on semantics, resulting in discarding the term 'centric' and 'centric relation'²⁵;
- a new perspective on the functional anatomy of the TMJs²;
- a critical review of the clinical use of the concept of CR²⁶; and
- the results of a survey among the Fellows of the Academy of Prosthodontics about the attributes that constitute the various definitions of the concept of CR.²⁷

In addition, surveys regarding consensus of opinion about concepts and definitions of CR have been conducted among faculty and students of 7 dental schools in the United States²⁸; among full-time faculty orthodontists and oral surgeons in all US orthodontic and oral surgery programmes²⁹; and among programme directors of all American and Canadian orthodontic residency programmes.³⁰ The results of these surveys indicate a wide variety of opinions upon the concepts of both CR and the occlusion of teeth.

Current evidence suggests that condylar positions when the jaw is in maximum intercuspation vary greatly among individuals.³¹ Therefore, any description of one specific position as being 'normal' (let alone 'ideal' or 'optimal') is doubtful and therefore cannot be accepted from both a biological and a scientific standpoint. In fact, each individual's closed jaw position is part of a dynamic movement, for example as it occurs during swallowing³² or during jaw clenching. Furthermore, in looking at condylar positions on a tomogram or an MRI, eccentricity of the condyles in relation to the mandibular fossae does not indicate a current problem nor a predisposition to a TMD.^{31,33} The condylar relation to the skull at full closure of the mouth and during all mandibular functions occurs on various parts of the articular eminence of the temporal bone, often on both sides of the crest, thereby leading to the description by Greene of the mandibular condyle being a 'ball on the hill'.² That article further clarifies that loading of the TMJ must take place between those bony structures which are covered with a layer of appropriate connective tissue (fibrocartilage). The thickness of this layer gives an indication of the load that may be exerted on these surfaces.³⁴ Since the bony roof of the mandibular fossa is thin and covered by a vascularised layer of fibrous connective tissue, this anatomical

region is not capable of sustaining severe biomechanical stress.³⁵ Instead, most of the load exerted by the mandibular condyle when the mouth is closed is directed towards the posterior slope of the articular eminence.

Therefore, the mandibular fossa should be considered as a 'neighbouring' structure to the TMJ, but not as a functional component of that joint. Consequently, a discussion of CR in terms of condyle-fossa relationships—as opposed to condyle-eminence relationships—should be avoided.² Although dental treatment that involves the establishment of a reproducible relationship between MIP and the TMJs is important for proper function,^{2,5,35} there is no agreement on where that condylar position should be because there is no universally acceptable definition of CR.

Okeson has attempted to clarify this situation by pointing out that positional stability^{5,36} of the condyles is determined by the force vector of the elevator muscles that pull the condyles into a supero-anterior position against the posterior slopes of the articular eminences, which are suited to withstand forces. Okeson describes this jaw relationship as the 'musculoskeletally stable' (MS) position.⁵ However, given differences in craniofacial morphology (e.g., the height of the condyle above the occlusal plane, the anteroposterior position of the teeth, the angulation of the masseter, temporalis, and lateral pterygoid muscles relative to the occlusal plane,³⁷ and the complex shape of the compartments within masticatory muscles with their heterogeneous activation), one cannot rely on simple force diagrams as presented by Okeson to defend his 'musculoskeletally stable' position.

While most individuals already have a reproducible condylar position that is determined by their MIP, it is obvious that this highly individualised position cannot and should not be assigned any specific name. However, the dentist who is providing major dental interventions may need to establish a new position by using clinical methods, such as bilateral guidance, perhaps combined with a jig, or a muscle-determined technique combined with a jig or a leaf gauge.^{7,10,11,38–42} Whenever a dentist wishes to adopt Okeson's approach in carrying out these procedures, it needs to be recognised that the 'musculoskeletally stable' (MS) position as defined by Okeson is essentially equivalent to CR,⁵ and therefore subject to all the same limitations of that approach. In the remainder of this paper, we will continue to use the term CR as we review the historical and current discussions about that jaw relationship.

4 | CENTRIC RELATION: DEFINITIONS

In the first edition of the GPT,⁴³ the definition of CR included the definition of guided closure. The method to locate CR allowed the clinician to determine the most retruded relation of the mandible to the maxilla. Over time, the original definition evolved under the influence of many, often contradictory, proposals and research findings.^{44–46} This has ultimately led to the currently accepted format in the latest Glossary of Prosthodontic Terms.¹

In the survey held under the Fellows of the Academy of Prosthodontics,²⁴ no majority consensus about the 'desired'

position of CR could be reached. The body of this survey included a Gothic Arch tracing, a Posselt diagram,⁴⁷ seven definitions from the previous Glossary⁴⁸ and two new proposed definitions. Ninety-four per cent of the respondents considered CR to be located at the apex of the Gothic arch tracing; eighty-four per cent agreed upon position 1 of the Posselt diagram to be CR. Two new definitions were proposed by the Academy of Prosthodontics in addition to the seven from the previous GPT.⁴⁸ The most preferred version, based on the choice of only 29% of the survey respondents, was included in the latest edition of the Glossary. Therefore, the current definition of CR in the GPT-9¹ is still controversial and it reads as follows: 'CR is the maxillomandibular relationship, independent of tooth contact, in which the condyles articulate in the anterior-superior position against the posterior slopes of the articular eminences. In this position, the mandible is restricted to a purely rotary movement. In this unstrained, physiologic, maxillomandibular relationship, the patient can make vertical, lateral or protrusive movements. It is a clinically useful, repeatable reference position for mounting casts'. Clearly, finding this theoretically defined version of CR may not always be achievable when trying to locate an 'ideal' mandibular position for an individual patient.

5 | CENTRIC RELATION AND REPRODUCIBILITY

Based on clinical investigations conducted in recent years,^{7,11} it appears that in the absence of oro-facial pain⁴⁹ for most individuals, CR is a reproducible⁵⁰⁻⁵² condylar position, irrespective of whether chinpoint guidance,^{11,50} bimanual manipulation⁷ or a muscle-determined method¹¹ has been used for localisation. It has been assumed that reproducibility (repeatability) is a valuable tool in assessing a CR record. For example, Keshvad⁴⁶ concluded in his closing remarks: 'Reproducibility is a jewel in the crown of validity'. However, reproducibility is not automatically a proof of validity.⁴⁶ One study by Piehslinger⁵¹ found reproducibility to be within 0.02 mm in approximately 84% of the subjects. Interestingly, she found the data to be similar in asymptomatic and symptomatic jaw joints without giving a specific TMD diagnosis. However, that article proposed using the term 'reference position area' to describe the jaw relationship.

Nevertheless, reproducibility of a clinically determined CR does not necessarily mean that it will be identical to the one found with an alternative method to locate CR.^{52,53} Nor does it mean that the clinically determined CR is a biologically superior position that the dentist should aspire to achieve for every patient, although many clinicians seem to believe that reproducibility is some kind of gold standard that proves the validity of using CR clinically.

To a great extent, reproducibility is also controlled by the lateral pterygoid muscles which, in turn, depends on the input from the central pattern generator in the brainstem.^{54,55}

6 | REASONS TO ABANDON THE TERM 'CENTRIC RELATION'

There are semantic, conceptual and practical reasons for suggesting that the continuous use of the term 'CR' is no longer appropriate:

1. The term 'CR' is semantically flawed because the adjective 'centric' does not tell us where the condyle should be in its 'relation' to the skull. Since the condyle will not be 'centred' in relation to the adjacent fossa, what is the semantic justification for continuing to use that term? How did the term 'centric' come about in the first place? Was it in relation to the development of articulators? Was it simply a problem of tunnel vision, based on the flawed assumption that the condyle was ideally seated in the centre of the mandibular fossa? This assumption proved to be incorrect in several studies.^{31,33} Furthermore, since the glenoid fossa is not a load-bearing structure, that question becomes even more irrelevant.
2. The term 'CR' is conceptually flawed because it is based upon the assumption that there is a place where condyles 'should be', accompanied by positive adjectives such as 'optimal', 'ideal' or 'biological'. Yet, each healthy individual's MIP actually determines where that person's condyles will be positioned relative to the articular eminence. Hence, a negative assumption is required to believe that a certain position is not 'biologically correct' as compared to another position. Differences between those two positions then become described as discrepancies, with a value judgement being placed on which one is biologically better.
3. The term 'CR' is also flawed in its practical application to the assessment of TMJ morphology and function. In order to use the traditional idea of CR clinically, the dentist must accept both the semantics and the theoretical assumptions described above. This puts the patient at risk for being assessed within a false framework that may lead to misinterpretation, overdiagnosis and inappropriate dental therapy. If, however, the dentist accepts an existing MIP-determined jaw relationship as being biologically acceptable for the vast majority of healthy dentate patients, there would be no need to conduct such assessments as a part of routine examinations of the stomatognathic system.

7 | CONCLUSION

Based on our analysis and interpretation of the dental literature dealing with condyle-to-articular eminence relationships, we recommend abandoning the term 'centric relation' because it has led to the various clinical problems described above. Instead, we should acknowledge that the average person will have a stable, repeatable and functional MIP that determines where the condyles and discs are located on their articular eminences. Therefore, no special assessment of the mandibular position needs to be carried out in these subjects.

Finding CR in any dentate individual requires the clinician to have a concept of finding an 'ideal', 'optimal' and/or stable *place* where

the mandible *ought to be*. Conversely, the new perspective proposed here suggests that the clinician does not need to find where the condyle and disc are meeting the articular eminence in healthy patients by following any manipulative protocol; instead, that relationship is already established by the existing MIP and the corresponding joint relationship within each patient.

The proposal for a new perspective regarding jaw positions, as discussed in this paper, should be helpful for practising orthodontists. First, it reduces the burden of trying to put the mandible in some 'ideal' position while simultaneously dealing with all the other challenges of finishing cases properly. Second, it provides evidence-based information for orthodontists to discuss (and debate) with each other about these issues. While some colleagues will continue to argue for the necessity of finishing cases in the CR position, many will realise that this gnathological concept is no longer defensible. Finally, discussions with referring dentists should persuade many of them that excellent orthodontic treatment does not depend on finishing cases in any particular TMJ relationship. Instead, the guidelines as recommended by the American Board of Orthodontics¹⁵ should be considered as the fundamental criteria for proper finishing of orthodontic cases.

Nonetheless, we should recognise that there are some individual patients who will present clinically with mandibular instability because they have an unstable MIP due to dental and/or skeletal injuries that have occurred or because they have a malocclusion that requires therapy. In these patients, establishment of a new jaw relationship will be an important component of providing the appropriate occlusal treatment procedures. There are three major groups of dental patients to whom this applies.

1. Edentulous (or partially edentulous) patients who require construction of partial or full removable denture prostheses.
2. Patients who need full-mouth reconstruction, with or without implants.
3. Patients who need full-mouth orthodontic and/or orthognathic therapy.

In addition, some patients may have significant intra-capsular TMJ problems that make it difficult to establish a reasonable jaw position. These conditions may range from unstable internal derangements of soft tissues to bony degenerative changes ranging from osteoarthritis to idiopathic condylar resorption. Not all such problems can be solved with currently available methods, but many of them can be successfully managed to some extent. Ultimately, the dental therapy of such patients may require considerable compromise when it comes to establishing a stable mandibular position, involving comprehensive clinical expertise.

Rather than aiming for a specific jaw position in the three groups described above, the clinician should simply aim for a reproducible condylar placement on the posterior slope of the patient's articular eminence, recognising that this is a variable relation among the population. Of course, any attempt to force the condyles to border positions, such as the traditional 'rearmost, upmost, midmost' positions, needs to be avoided by all means. Once a new MIP has been established, both

the new dental relationship and the new jaw relationship will become 'normalised' through cellular remodelling (similar to teeth 'settling in' after completion of orthodontic treatment), and occlusal as well as condylar stability can be expected to occur in most cases.

CONFLICT OF INTEREST

As the primary author of 'Centric relation critically revisited—What are the clinical implications', I declare on behalf of myself and my co-authors Prof. Dr. J.C. Türp and Prof. Dr. C. Greene that we have no conflict of interest in publishing the aforementioned manuscript.

AUTHORS CONTRIBUTIONS

All authors made substantial contributions to conception and design of the manuscript and to the analysis and interpretation of data. All authors were involved in drafting the paper and critically revising it for important intellectual content. And, finally, all authors approved of the version to be published.


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DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analysed in this study.

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