


# Centric relation—A biological perspective of a technical concept

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## Abstract

**Background:** Few terms and concepts have been so extensively debated in dentistry as the words 'centric relation' (CR). Debates involve its biological, diagnostic and therapeutic usefulness.

**Methods:** A review of the literature on the current concepts on CR as a diagnostic or therapeutic aid in dentistry was provided. Clinical trials assessing the superiority of one CR recording method over the others to identify patients with temporomandibular disorders (diagnostic use) or to manage patients with prosthodontic or orthodontic needs (therapeutic use) were tentatively included.

**Results:** Due to the absence of literature addressing either of the above targets, a comprehensive overview was provided. The diagnostic use of CR as a reference position to identify the correct position of the temporomandibular joint condyle within the glenoid fossa is not supported and lacks anatomical support. From a therapeutic standpoint, the use of CR can be pragmatically useful in prosthodontics as a maxillo-mandibular reference position when occlusal re-organization is warranted and/or when the position of maximum intercuspation is no longer available.

**Conclusions:** The derived occlusal goals from a diagnostic misuse of CR are generally the result of circular reasoning, that is a technique is based on the recording of a certain condylar position that is believed to be 'ideal' and the treatment is considered successful when such position is shown by the specific instrument that was manufactured for that purpose. The term 'Centric Relation' might be replaced with the term 'Maxillo-Mandibular Utility Position'.

## KEYWORDS

centric relation, prosthodontics, prosthetic dentistry, temporomandibular disorders, temporomandibular joint, TMD

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## 1 | INTRODUCTION

Since its introduction, few terms and concepts have been so extensively debated in dentistry as the words 'centric relation' (CR). Generations of dentists have been educated and trained with the concept that a centric relation-defined relationship between the temporomandibular joint (TMJ) condyle and the glenoid fossa is needed for a proper homeostasis of the stomatognathic system. Stemming from this concept, CR has been therefore used, for decades, for diagnostic and therapeutic goals in several fields of dentistry. An analysis of the evidence, rationale and utility underlying these uses of CR is at the basis of this review.

## 2 | MATERIALS AND METHODS

A systematic search in the PubMed database was performed on 25 March 2023, with the aim to identify all pertinent articles on the topics of the use of centric relation for diagnostic and/or therapeutic purposes in dentistry. The search queries provided that the keyword term 'centric relation' was combined with either the keyword term 'diagnosis' or 'treatment'. Limit was set to clinical trials, and inclusion in the review was tentatively reserved to investigations assessing the superiority of one centric relation recording method over the others to identify patients with temporomandibular disorders (diagnostic use) or to manage patients with prosthodontic or orthodontic needs (therapeutic use).

## 3 | RESULTS

The query 'centric relation' and 'diagnosis' provided 746 citations, while the query 'centric relation' and 'treatment' identified 760 citations. Examination of the titles and abstracts (TiAb) led to the exclusion of all papers, none of which had a study design aiming to address either of the above targets.

Based on the absence of high level of evidence on the topics of this review, a comprehensive summary of current concepts about the use of CR for diagnostic and therapeutic aims is thus provided.

Early gnathological precepts converged towards a positional definition of CR, which was initially believed to be the uppermost retruded condylar position. This definition was then progressively modified based on the paradigm evolution, and, for an historical appraisal, readers are referred to the various editions of Glossary of Prosthodontic Terms (GPT), from GPT-1, published in 1956,<sup>1</sup> through GPT-9, published in 2017.<sup>2</sup> Currently, CR is defined as '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'.<sup>2</sup>

A number of CR recording methods have also been proposed over the last decades.<sup>3</sup> Several strategies include, among others, purported muscle deprogramming devices (e.g. anterior Jig, bite plane and leaf gauge), manipulation techniques (e.g. chin-point guidance, bimanual manipulation, Roth Power Centric and Dawson's manoeuvre), occlusal stimulation strategies (e.g. cotton rolls), artificial peripheral muscular relaxation with transcutaneous electrical nerve stimulation (TENS) (e.g. neuromuscular dentistry) and others (e.g. free closure, swallowing). Most techniques date back to the third quarter of the past century, and some descriptive and comparative studies have been published since then.<sup>4-11</sup> Obtaining an overall comparative summary of findings is however complicated, especially considering the changing nature of CR definition itself.<sup>12,13</sup>

In general terms, from a condylar position standpoint, instrumentally achieved muscle relaxation techniques (e.g. TENS) obtain a more anterior position than the habitual position.<sup>6</sup> A deprogramming achieved with an appliance seems to put the condyle in a retruded position with respect to free closure.<sup>5</sup> In general, all techniques based on appliance conditioning are characterized by initial tooth contacts located posteriorly and obtain the largest occlusal discrepancy when compared to free closure of the mandible,<sup>7,10</sup> but some authors also found a more anterior position than maximum intercuspidation.<sup>11</sup> The free closure position seems to be the most reproducible one.<sup>5</sup>

The interpretation and comparison of studies on CR recording techniques are complicated by the assumption that, while CR is, by definition, a joint position independent of tooth contacts, the differences between the various recording techniques are easier to visualize at the occlusal than at the joint level. In this sense, it is worth mentioning that most assumptions on CR-induced condylar position have been drawn from analysis of indirect measurements (e.g. pantographic recordings and condylar axis position).<sup>5,7</sup> Direct imaging techniques, though, showed that the differences in the position of the condyle within the glenoid fossa during different occlusal registration techniques, even if evaluated by magnetic resonance, which is not the standard of reference technique for the visualization of bone tissues, are only in the order of tenths of millimetres.<sup>14,15</sup> In addition to the differences and inconsistencies related to tooth and condylar position among the different techniques, electromyographic activity elicited by shifting the condyles via occlusal stimulation is unclear,<sup>7,16</sup> which detracts from a full comprehension of stomatognathic physiology.<sup>17,18</sup> Furthermore, factors such as facial morphology, asymmetry and the presence of pain are important confounders to take into consideration.<sup>19-25</sup> Importantly, already in the eighties there were claims that the prerequisite for using CR was the presence of a 'healthy' TMJ.<sup>26</sup>

## 4 | DISCUSSION

Taken together, findings on the various recording techniques are thus unsupportive of the superiority of one method over the others in terms of biological value or clinical usefulness.

Nonetheless, the concept of using CR as a diagnostic or treatment target continues to strongly influence approaches to the evaluation of patients' needs and subsequent treatment planning<sup>27</sup> and investigations are still performed on comparative CR recording techniques.<sup>28,29</sup> Some earlier investigations also showed a non-homogeneous teaching of CR concepts and techniques among dental faculties,<sup>30,31</sup> which lends credence to the interesting hypothesis that the training era and bias related with the belonging to a certain 'philosophy' may influence the interpretation of the concept of CR.<sup>27</sup> A glimpse of this scenario is best summarized by two surveys assessing clinicians' knowledge and definition of CR. The authors reported that, in general terms, a fair agreement about the ideal requirements of a definition was not reached between the interviewed professionals.<sup>27,32</sup>

A comprehensive review by Rinchuse and Kandasamy<sup>33</sup> further summarized the drawbacks of CR-stated uses, since the first gnathological assumptions of its usefulness to fabricate dentures that led to the official introduction in the GPT in the fifties to the more recent debates about its biological, diagnostic and therapeutic usefulness.

From a therapeutic standpoint, the use of CR can be pragmatically useful as a maxillo-mandibular reference position when maximum intercuspitation is lost (e.g. many teeth preparation and edentulism) and/or occlusal re-organization is warranted (e.g. restoring a worn dentition, planning a mandibular advancement during orthognathic surgery, any situation where the current occlusal position is not conducive or advantageous to a planned extensive restorative intervention). From a diagnostic standpoint instead, CR has been proposed as a necessary step to evaluate the correctness of occlusal contacts in relation to the TMJ from which treatment needs can actually be generated. These two different uses of the same concept, partially superimposed and apparently similar, rely on two extremely different intellectual and biologic approaches. In the first case, the term 'centric relation' indicates a pragmatic use of a utility maxillo-mandibular reference position, while in the second case, the evaluation of CR position becomes the diagnostic concepts underpinning the rationale for evaluating the stomatognathic system function and dysfunction. The potential misuse of CR as a diagnostic concept in TMD patients, which is erroneous by definition since the TMJ is required to be 'healthy' for CR to be found, led some authors to a nihilism approach against CR as a whole.<sup>34,35</sup> Such a negative judgement is comprehensible, but not necessarily productive to move dentistry on to a more homogeneous conceptualization of the possible technical requirements of CR for some selected prosthodontic needs.

Based on that premise, the next sections of this manuscript will discuss the evidence and biological soundness of the diagnostic use of centric relation and offer a therapeutically-based convenience approach.

## 5 | CENTRIC RELATION AND ITS DIAGNOSTIC USE

For decades, the topic of CR as a diagnostic concept has attracted much debate within different communities of dental practitioners.

Historically, the concept of CR was drawn from the assumption that a certain position of the TMJ condyle within the glenoid fossa was needed to warrant a proper function of the stomatognathic system.<sup>36</sup> As a result, the impact of CR as a diagnostic concept in dentistry is not negligible. For instance, a discrepancy between the interarch tooth contacts in CR and maximal intercuspitation (MI), also termed 'CR-MI slide', has been considered, for generations of dentists, a risk factor for TMDs.<sup>37-39</sup> Based on that, occlusal adjustments have been proposed as a therapy or even a prevention for TMJ disorders, not even considering that the detection and extent of a CR-MI slide is strongly influenced by the CR recording technique. Actually, the lack of validation and therefore anecdotal nature of this assumption is further indirectly confirmed by the absence of good quality evidence on the effectiveness of occlusal adjustments for treating and preventing TMJ dysfunctions.<sup>40-42</sup> Interestingly, controversies about the role of CR-MI slide as a risk factor for TMJ disorders have been paradoxically diminished thanks to the evolution of CR definition.<sup>43</sup> Thus, despite some early cross-sectional findings of a possible higher prevalence of CR-MI discrepancies in patients with TMDs,<sup>44,45</sup> current evidence on TMDs has discarded the role of features of dental occlusion as a clinically meaningful target.<sup>46-48</sup> Interestingly, CR-MI slides may more likely be considered as a possible consequence of the presence of clinical symptoms (e.g. degenerative joint diseases, muscle fatigue and joint pain) rather than their cause.<sup>24,49</sup> Thus, from a biological viewpoint, the clinical relevance of any CR-MI slide in the natural dentition is questionable, and the old beliefs about the importance of condylar position and the subsequent teeth contacts in MI, which are still alive in some dental communities, should be definitively abandoned.<sup>41</sup>

From an anatomical standpoint, the evolution of CR definition has progressively changed the concept from its original 'centricity' within the glenoid fossa, towards an antero-superior position and loading.<sup>1-3,50</sup> In this sense, anatomical studies on the distribution of TMJ cartilage layers have confirmed the antero-superior direction of force vectors, with a component of condyle rotation and translation with respect to the disc and articular eminence, respectively.<sup>51-53</sup> On the contrary, the statement that CR is the only position in which the mandible is restricted to a purely rotatory movement<sup>2</sup> is likely biologically unfounded. Indeed, such CR definition is still based on the old concept that the initial phase of mandibular movement provides a pure rotation of the condyle.<sup>54</sup> Such hypothesis has been repeatedly challenged over the past decades and already dismantled anatomically in the seventies, since the mandible, as a body, has always a rotating movement around a fulcrum that is located somewhere along the ramus.<sup>55-57</sup> It is thus recommendable that the CR definition is adjusted accordingly.

The search for a pure rotational movement at the TMJ level is, at best, a biologically unfounded statement; at worst, it leads to an erroneous clinical assumption that further underlies and contributes to the marketing of unneeded dedicated diagnostic hardware and software. The objective of such a search for a condylar hinge axis is purely mechanical, based on the purported need to trace an axis that can be duplicated in an individual articulator used in combination

with an individual face bow and be used to identify the so-called centric occlusion. Such an approach may have a pragmatical advantage according to some authors, but does not have any proven clinical superiority with respect to more simple techniques for occlusal reorganization, especially considering that planning an occlusal change by starting from MIP in the articulators (either analogic or virtual) carries an inevitable error of the method (i.e. the articulator is not the mouth) that is actually not measurable. Thus, it is likely that the neuroplastic skills of the stomatognathic system are responsible for the clinical adaptation to restorations organized according to different CR principles.

On the contrary, unfortunately, all these arbitrary speculations led to overtreatment. Neuromuscular dentistry, functional occlusion and neuro-occlusal rehabilitation philosophies are just examples of theories that claim the need for a certain maxillo-mandibular relationship as a requirement to manage and/or prevent TMDs. Currently, none of the purported diagnostic instruments (e.g. chair side surface electromyography, condylography, kinesiography and postural platforms) have been able to correctly identify, with adequate levels of sensitivity and specificity, health from disease.<sup>23,58-60</sup>

Another anatomical issue that needs attention is the position of the disc. Studies on the position of the TMJ disc have repeatedly shown that there is a high degree of biological variability, both in patients and healthy volunteers.<sup>61-63</sup> It has also been shown that, independent on the presence of clinical symptoms, there is a high frequency of similar findings between the two TMJs in terms of the presence disc displacements and internal derangements.<sup>64</sup> Thus, a better appraisal of the complex relationship between anatomy, imaging and clinical findings should be recommended when considering what is physiological and what is not.<sup>65</sup>

Therefore, over the years, a shift from the rigidly diagnostic concept of a positionally predetermined CR to a more modern concept of biological variability within the framework of TMJ physiology and anatomy has occurred. This shift should basically dismantle the use of the CR concept in patients with TMDs because they lack the prerequisite assumption of a healthy joint. Nonetheless, the use of the term centric relation still seems to focus on the positional aspects of the condyle-glenoid fossa relationship and neglects the fact that a relational homeostasis can be warranted almost independently of the condylar position within the fossa thanks to the constant neuromuscular, bone and cartilage tissue adaptations. While anatomical and physiological variability appear compatible with TMJ health, formative didactic and clinical experiences and the predominance of technical therapeutic protocols in many aspects of dentistry may partly elucidate the persistence of CR as a biologically valid and diagnostically important tool in some clinicians' mind, and explain the difficulty that some communities of professionals have to abandon the so-called Third Pathway to manage TMDs, viz., treatment strategies based on the correction of dental occlusion and condylar position.<sup>41</sup>

The absence of any biological rationale and the lack of a reference technical protocol to define/assess CR have, therefore, their most important impact in the everyday clinical practice of patients

with TMDs and their purported prevention. Indeed, the presumption of 'superiority' associated with the use of CR as a reference position is often only supported with dogmatic and anecdotal theories that are inherently associated with an overdiagnosis and subsequent overtreatment (and even over prevention) of TMDs. The potential clinical side effects, patient cost and morbidity and potentially unethical basis of such conducts have been repeatedly discussed in the literature.<sup>66-69</sup>

The dental and medical professions seem to be characterized by a long temporal gap in the science transfer process, that is, evidence and suggestions coming from research are rarely promptly introduced in clinical practice and academic teaching curriculae, leading to the persistence of traditionally held, yet not evidence-based, concepts that often delays the introduction of new diagnostic and therapeutic paradigms.<sup>43</sup> For instance, the recent evolution of bruxism construct and definition which is including orofacial pain and sleep medicine has not been fully appreciated in dentistry yet.<sup>70-73</sup>

With this in mind, though, there is no doubt that the dental practitioner needs guidance and clinical protocols over how and when to adopt a new maxillo-mandibular reference position when occlusal re-organization is needed during the course of orthodontic, prosthodontic and surgical therapy.

With this in mind and, as recently highlighted in some articles,<sup>34,35</sup> the current CR definition appears still flawed or at least inaccurate. The above-described anatomical and conceptual concerns hamper the process of understanding that technical prosthodontic, orthodontic and surgical needs should be separated from any biological considerations. Neuroplasticity of the system often allows adaptation and provides paradoxical support to many claims that are just examples of logic in the absence of science. Such bias self-perpetuate because of the favourable environment in which dentists work, that is, a stomatognathic system with good neuroplastic and adaptation properties<sup>74-76</sup> and a set of benign, often self-limiting musculoskeletal conditions (i.e. temporomandibular disorders).<sup>69,77,78</sup>

Indeed, alongside claims to abandon the dogmatic use of CR,<sup>35</sup> there have also been proposals to modify, from a technical usefulness viewpoint, the definition of centric relation.<sup>79-81</sup> Thus, while it seems reasonable to suggest that there is a general agreement on the fact that CR is still viewed too dogmatically, criticism in the form of nihilism should be abandoned in favour of constructive reasoning and critical thinking to find the best possible strategy to move towards evidence-based dentistry. Based on that, the biological reasons for abandoning the current CR concept on one hand have been previously explained, and the technical reasons for maintaining a modified CR concept for technical reasons on the other hand will be reviewed below.

## 6 | CENTRIC RELATION FROM A TECHNICAL PERSPECTIVE

In practical terms, occlusal re-organization, the only condition where an existing maximum intercuspal position is not going to

be the maxillomandibular reference position at the end of a dental treatment, is less frequent than advocated. A maxillomandibular reference position independent from tooth contact may be an advantageous option for treatment in a limited number of conditions, and it is likely a real necessity of treatment in even fewer conditions. A non-dental maxillo-mandibular position (i.e. 'CR') is obviously a reference position during the treatment of edentulous patients. It may also facilitate the dental office-to-dental laboratory communication in the case of patients with multiple teeth preparations without a stable MI. It can be also used for any patients whose treatment requires occlusal alignment, such as in cases with poor interarch space, tooth malposition, worn dentition or when a different occlusal relationship is needed to address patient's aesthetic complaints. While this is not an inclusive list of indications, it is also true that, in most cases, similar treatment results can be achieved and maintained by using the existing MI and modify it, if needed, by minimal progressive changes.<sup>82</sup> It should be clear, as a consequence, that any of these choices is therefore arbitrary and can be adopted in the context of a pragmatic, cost-effective and least invasive treatment approach.

Exceptions to this general rule may be represented by complex orthognathic surgery treatments, where the change in the interarch/interdental position after the treatment is immediate.<sup>83-85</sup> Similarly to what previously mentioned, a survey among orthodontists and maxillofacial surgeons reported lack of consistency among practitioners regarding a definition of centric relation as it relates to orthognathic surgery. In particular, a high level of inconsistency exists between specialties and within practitioners in each specialty.<sup>86</sup>

To a certain extent, the debate on the need to abandon the use of the term CR may seem a non-fruitful discussion with poor clinical relevance, based on the above considerations that different techniques may exist to record CR and that imaging findings suggest the existence of minimal positional differences between such techniques.<sup>14</sup> Further confusion arises if one considers the prevalence of joint symptoms and signs of degenerative joint disease in patients who require prosthodontics treatments. Epidemiological findings suggest that up to one-third of the general population may show mild signs that would fit with an axis I Research Diagnostic Criteria for TMD diagnosis.<sup>87</sup> Clinicians should be aware of this fact when adopting any peculiar technique that leads to purported condylar repositioning and subsequent occlusal re-organization.

## 7 | CONCLUSIONS

Current evidence supports, if so chosen by the treating clinician, the use of CR as one of the pragmatic approaches to address the need for occlusal re-organization. This use of a new maxillomandibular position for clinical treatment is part of dentistry, and its judicious use is definitely not a problem per se.

Such treatment goals, however, are not to be confused with using CR as a diagnostic method. While this use may appear logic and consequential to an inexpert observer, is supported neither by

science nor sound biological background. The derived occlusal goals are therefore generally the result of circular reasoning, that is a technique is based on the recording of a certain condylar position that is believed to be 'ideal' and the treatment is considered successful when such position is shown by the specific instrument that was manufactured for that purpose. It is not a secret that instruments are abused in some practitioners' communities to record proxy outcomes of mandibular movement, muscle activity and/or condylar position and misused to judge those parameters as something that indicates disease.

With these premises, we would like to suggest the replacement of the term 'Centric Relation' with the term 'Maxillo-Mandibular Utility Position', defined as the maxillomandibular relationship adopted for some occlusal reorganization treatments.

## AUTHOR CONTRIBUTIONS

DM and MF conceptualized the article, wrote the first draft and finalized the manuscript; CE, CEP and FC critically revised the article and approved the final version.

## CONFLICT OF INTEREST STATEMENT

The authors declare they do not have any conflicts of interest.

## PEER REVIEW

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## DATA AVAILABILITY STATEMENT

No original data are presented in this manuscript.

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