J Indian Prosthodont Soc (July-Sept 2013) 13(3):149–154
DOI 10.1007/s13191-012-0209-7

REVIEW ARTICLE

Centric Relation Definition: A Historical and Contemporary Prosthodontic Perspective

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Received: 13 July 2011 / Accepted: 18 October 2012 / Published online: 31 October 2012

Abstract Centric relation (CR) is a core topic of dentistry in general and prosthodontics in particular. The term CR has become thoroughly confusing because of many conflicting definitions. Unfortunately definition of CR changed repeatedly over past ten decades. All the existing definitions in the dental literature, for the past 81 years, are segregated into definitions from 1929 to 1970, 1970–1980, and 1980–2010 and are critically analyzed. Both PubMed (key words: centric relation/centric jaw relation) and hand searches were employed, from citation in other publications, to identify relevant articles in English language peer reviewed PubMed journals from 1956 to 2010; although the review is from 1929. Numerous definitions for CR have been given, however, no consensus exists and the definition given by a current glossary of prosthodontic terms is confusing. It relates CR to many clinically invisible parts and cannot guide a dental surgeon to record the CR following its description. The purpose of this article is not only to review all the definitions critically but to propose a self explanatory definition to minimize the confusion in the minds of dental practitioners and students for better understanding of the concept of CR. Centric relation is clinically significant since it is the only clinically repeatable jaw relation and the logical position to fabricate prosthesis.

Keywords Centric jaw relation · Jaw relations · Hinge axis · Head of the condyle · Condyle

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Introduction

Centric relation (CR) is the most controversial concept in dentistry. The concept of CR emerged due to the search for a reproducible mandibular position that would enable the prosthodontic rehabilitation. Research in the field of CR has been controversial for more than 100 years. There are over 26 definitions of CR since the term was first developed as a starting point for making dentures [1]. The long standing history of CR is confusing since it has been changed numerous times over the years. It is confirmed in the glossary of prosthodontic terms (GPT) that there is still no consensus exists about the definition as latest GPT still gives seven definitions for CR. Most of the controversies are pertaining to the position of the head of the condyle in the glenoid fossa during centric relation position. This ranges from a retruded posterior position, to superior position and then to an anterior superior position [1–4]. The definition of centric relation has evolved over the years and with advanced understanding of mandibular movement it may change again in future [5]. Theoretically CR is being discussed under the heading of jaw relations. Jaw relations are the relationships of the mandible with the maxilla. In this context too much importance was given to the position of the head of the condyles in the glenoid fossa which ultimately resulted in a lot of confusion. This confusion was due to the invisibility of the most unique, enigmatic temporomandibular joint. For almost the last six decades

we assumed CR to be the most retruded position of the heads of the condyles in the glenoid fossae [1]. Recently we could come to a conclusion that it is not the most retruded position of the heads of the condyles but rather the most anterior and superior position. Whether the patient has achieved this position clinically while recording CR or not can only be checked by opening the temporomandibular joint and visualizing the disk complexes [2–4]. An understanding of CR is an integral part of clinical decision making in several restorative procedures. Of all the jaw relationships a dentist must record CR which is the only clinically comfortable, repeatable and logical jaw relation and so the most important and critical [6]. A missed CR destroys the accuracy of even the most sophisticated instrument system and can lead to failure of a prosthodontic treatment [7]. There is hardly any aspect of clinical dentistry that is not adversely affected by a disharmony between the articulation of the teeth and the centric relation position of the temporomandibular joints [8]. The acceptance of one definition is necessary to improve communication at all levels of dentistry. Definition of CR has created more controversy than any other dental subjects, several factors contributed to this confusion [9, 10]. This article is a review of all the definitions given till date and it has been organized as follows. First various definitions used to define CR are listed as-CR from 1929 to 1970, in 1970–1980, and through 1980–2010, followed by a critical discussion and evaluation of CR developed over the years. Finally a new definition has been proposed for better understanding and to guide the clinician to record the CR clinically.

Centric Relation from 1929 to 1970s

Hanau [1929] defined CR as 'the position of the mandible in which the condylar heads are resting upon the menisci in the sockets of the glenoid fossa, regardless of the opening of the jaws'. He believed this relation is either strained or unstrained but preferred the unstrained CR associated with an accepted opening for the reference jaw relation [11]. Goodfriend [1933] considered the 'centricity of the condyles in centric relation to be an abnormal position'. He stated that the most desirable position exists when the condyles rest near the lower posterior border of the articular eminences with the menisci serving as cushion [2, 4]. Niswonger [1934] described CR as a position where the patient can 'clench the back teeth' [11]. Schuyler [1935] defined CR as 'upper lingual cusps are resting in the central fossae of the opposing lower bicuspids and molars' [11]. Thompson [1946] stated that 'some believed that, in CR, the condyles are in the most retruded position in the fossae, while others maintained they are not' [11]. Robinson [1951] stated that the mandible 'can be retruded beyond what we should consider centric into a strained retruded position' [11]. McCollum and Stuart [1955] proposed a definition for CR in which the condyles are in a 'rearmost, uppermost and midmost (RUM) position in the glenoid fossae' [11].

GPT-1 [1956] defined CR as 'the most retruded relation of the mandible to the maxilla when the condyles are in the most posterior unstrained position in the glenoid fossa from which lateral movements can be made, at any given degrees of jaw separation' [12]. Moyers [1956] defined CR as 'the position of the mandible as determined by the neuromuscular reflex first learned for controlling the mandibular position when the primary teeth were in occlusion' [1]. Stallard [1959] defined CR of the mandible as 'the rearmost, midmost, untranslated hinged position. It is a strained relation as are all border relations. It is the only maxillamandibular relation that can be statically repeated' [6]. GPT-2 [1960] defined the CR as 'the most posterior relation of the mandible to the maxilla at the established vertical relation', and also gave six other definitions [13]. Avant [1960] declared the 'seven definitions of CR' that appeared in GPT-2 [1960], as 'regrettable' and stated that CR is a bone-to-bone (mandible to maxilla) relation, whereas centric occlusion is a tooth-to-tooth (mandibular teeth to maxillary teeth) relation [11]. McCollum [1960] defined CR position as 'the most retruded position of the idle condyles in the glenoid fossa' [14]. Boucher [1964] stated 'CR is the most posterior relation of the mandible to maxillae at the established vertical relation' [11]. Graber [1966] thought that CR was an 'unstrained, neutral position of the mandible and is deviating neither to the right nor to the left and is neither protruded nor retruded' [11]. Glickman [1966] stated that CR was 'the most retruded position to which the mandible can be carried by the patient's musculature' [11]. Goldman and Cohen [1968] defined CR as 'the most posterior relation of the mandible to maxilla from which lateral movements can be made' [11]. GPT-3 [1968] defined CR as 'the most retruded physiologic relation of the mandible to the maxilla and from which the individual can make lateral movements'. It is a condition that can exist at various degrees of jaw separation. It occurs around the terminal hinge axis [15]. Debate on the definition of CR escalated. Posterior border closure, relaxed closure, bracing position, hinge position, ligamentous position, retruded contact position, terminal hinge position added confusion to term CR. Schweitzer [1969] gave 'almost 40 definitions of CR, it would be presumptuous on my part to offer another' [11].

Centric Relation in 1970–1980s

Dawson [1973] defined CR as 'the most superior position the condyle can assume in the glenoid fossa and it is not

unstrained' [16]. Smith [1975] considered CR to be 'the most retruded position of the mandible' and concluded that the gothic arch tracing provides the most retruded and most repeatable position and thus was the most precise method [2, 4]. GPT-4 [1977] defined CR as 'the jaw relation when the condyles are in the most posterior, unstrained position in the glenoid fossa at any given degree of jaw separation from which lateral movements can be made' [17]. Williamson et al. [1977] stated that the hinge axis and CR are the same; adding that this axis occurs when the mandible is in CR and a pure rotational movement of the mandible is produced in the sagittal plane [18]. Lucia [1979] stated that 'the mandible is in CR when the centers of vertical and lateral motion are in the terminal hinge position' [19]. Myers et al. [1980] defined CR as 'the most posterior unstrained relation of the mandible to the maxilla at a given degree of jaw separation'. They stated that the more posterior the condyles, the more acceptable the position [20].

Centric Relation During 1980–2010

Gilbe [1983] defined CR as 'the most superior position of the mandibular condyles with the central bearing area of the disc in contact with the articular surface of the condyle and the articular eminence. This position may not always be possible to attain due to anterior dislocation of the disc [21]. Dawson in 1985 stated that 'CR is achieved when the properly aligned condyle-disk assemblies are in the most superior position against the eminentia irrespective of tooth position or vertical dimension' [22]. GPT-5 and 6 [1987, 1994] defined the CR as 'the relation of the mandible to the maxilla when the condyles are in their most posterior position in the glenoid fossa from which unstrained lateral movements can be made at occluding vertical dimension normal for the individual' [23, 24]. American College of Prosthodontist [1994] defined CR as 'the spatial relationship between the maxilla and mandible where the condyles relate to the articular eminence in a ventro-cranial position with the pars intermedia of the disc' [25]. GPT-7 [1999] defined centric relation as 'a maxillomandibular relationship in which the condyles articulate with the thinnest avascular portion of their respective disks with the complex in the anterosuperior position against the shapes of the articular eminences. This position is independent of tooth contact. This position is clinically discernible when the mandible is directed superiorly and anteriorly and restricted to a purely rotary movement about a transverse horizontal axis' [26]. Authors of GPT 5 (1987) stated that 'this term (CR) is in transition to obsolescence'. Authors of the latest GPT-8th edition (2005) [27] continued giving following seven acceptable definitions.

1: the maxillomandibular relationship in which the condyles articulate with the thinnest avascular portion of their respective disks with the complex in the anterior–superior position against the shapes of the articular eminencies. This position is independent of tooth contact. This position is clinically discernible when the mandible is directed superior and anteriorly. It is restricted to a purely rotary movement about the transverse horizontal axis (GPT-5) **2**: the most retruded physiologic relation of the mandible to the maxillae to and from which the individual can make lateral movements. It is a condition that can exist at various degrees of jaw separation. It occurs around the terminal hinge axis (GPT-3) **3**: the most retruded relation of the mandible to the maxillae when the condyles are in the most posterior unstrained position in the glenoid fossae from which lateral movement can be made at any given degree of jaw separation (GPT-1) **4**: The most posterior relation of the lower to the upper jaw from which lateral movements can be made at a given vertical dimension (Boucher) **5**: a maxilla to mandible relationship in which the condyles and disks are thought to be in the midmost, uppermost position. The position has been difficult to define anatomically but is determined clinically by assessing when the jaw can hinge on a fixed terminal axis (up to 25 mm). It is a clinically determined relationship of the mandible to the maxilla when the condyle disk assemblies are positioned in their most superior position in the mandibular fossae and against the distal slope of the articular eminence (Ash) **6**: the relation of the mandible to the maxillae when the condyles are in the uppermost and rearmost position in the glenoid fossae. This position may not be able to be recorded in the presence of dysfunction of the masticatory system **7**: a clinically determined position of the mandible placing both condyles into their anterior uppermost position. This can be determined in patients without pain or derangement in the TMJ (Ramsfjord).

Discussion

Definition of CR has evolved over the past century from being a posterior superior position of the condyle in relation to the glenoid fossa to an anterior superior position. Before 1987, CR was considered a retruded (posterior–superior) condylar position. The concept of "the more retruded the better" was still valid in the 1980s and many of the authors were reporting their methods of positioning the mandible more posteriorly [1–4]. Hoffman in his study concluded that the further posterior the guided position, the more likely the condyles were to be inferiorly displaced. His study was exceptional that fulfilled the criteria of a defined sample with a sufficient number of subjects to permit analysis of condylar position [28]. Fredrick,

Pameyier and Stallord studied the influence of two factors: force and distalization as they relate to various techniques commonly employed by the dentist in recording CR. They believed that the most retruded position of the mandible is the ideal position [29]. Christensen [2004] said that he and most practitioners accept the concept that 'CR is the most comfortable posterior location of the mandible when it is manipulated gently backward and upward into a retrusive position' [30].

An impetus for the shift in thinking was the introduction of the more sophisticated Temporomandibular joint (TMJ) imaging that demonstrates TMJ and has led to the change in the definition of CR from a posterior–superior to an anterior–superior position [1]. The argument for anterior–superior positioned condyles was the belief that distally displaced condyles can cause anterior and medial displacement of TMJ disks. Dawson argued that CR is not the most retruded position of the condyles nor it is an unstrained position. It is not unstrained because it is achieved by firm contraction of the elevator muscles. It is not most retruded because it is possible to force the condyles distal to centric relation but such distal displacement occurs only with a downward movement away from CR [15]. Ismail et al.[1980] conducted a radiographic study of condylar position and concluded that in CR position both condyles were placed in a more posterior and superior position in their fossa [14]. The preponderance of evidence available suggests that there is no one ideal position of the condyle in the glenoid fossa, but there is a range of normal positions [11, 31–36]. Celenza concluded that there might be several acceptable CR positions [37]. Shafagh et al. suggested from their study that there is a difference in condylar position between morning and afternoon and it was suggested that condyles were in their most antero inferior position in the morning and in their most supero posterior position in the evening and CR was repeatable for few patients but in most there was variation. The greatest variation was in supero-inferior direction [38]. Serrano [39] in 1984 agreed with this by stating that CR is not only one position but a range of positions. Lindauer and colleagues studied the condylar movements and centers of rotation. They found that all the subjects studied demonstrated both rotation and translation during the initial phase of jaw opening and none had a center of rotation at the condylar head. Their findings support the theory of constantly moving instantaneous center of jaw rotation that is different for different people. Based primarily on dialectical considerations rather than on evidence, anterior to mid condyle position appears to be favored over posterior, retruded positions. The change of definition of CR from posterior–superior to an anterior–superior position logically has eliminated or reduced the magnitude of centric slides [40]. Controversies and confusions have arisen in the clinician's understanding of the present GPT definition [1–4, 41, 42]. Keshavad et al. extensively reviewed the CR and concluded that there is still no evidence in the literature to prove if there are positional differences at the level of condyle itself or the mandible during CR, however, that all positional differences are related to mandible and not to the condyle unless the position of the condyle is clearly illustrated by a three dimensional diagnostic tool such as computerized tomography scan. The only possible way of observing the condylar position in CR seems to be opening the temporomandibular joint and looking at it while it is in a specific spatial position which is totally impractical, although it can be applied to cadavers [2]. Radiography is recommended as a solution to this problem but this method can only assess two dimensionally the position of one joint at a time [2–4] Further they concluded that there is a lack of consistency among specialties' and within the practitioners' in each specialty [43]. This absence of consensus regarding the ideal mandibular position has created a quest in search of a practically feasible definition for CR. It is thus possible to agree with Sutcher [44] who stated that the validity of position should be recognized clinically and a clinical approach to CR is meaningful.

Author's Views

Although the previous and present GPT definitions are diametrically opposite to each other, methods to record centric relation remained the same [45–47]. This suggests that the new invention of the position of the head of the condyle in the glenoid fossa is of great theoretical significance. Definitions should be self explanatory without any further clarifications. This latest definition does not enlighten on the correlation of the centric relation and the vertical relation. CR is related to many invisible parts such as head of the condyle, articular disk, glenoid fossa, slopes (shapes) of articular eminence etc. With the present most widely accepted definition, neither an experienced dental surgeon nor a beginner can be sure of recording correct CR by following the description of the definition. This perennial problem faced by the dentist regarding the CR was simply stated by Nuelle and Alpern as 'no dentist is knowledgeable enough to know the proper three dimensional position for two asymmetrically angulated condyles, irregularly and individually suspended in a polycentric hinge joint [48, 49]. From this discussion it is established that a much needed terminology for more specific description of CR is needed.

Definition given in GPT-2 sounds logical of all the definitions put forth so far, as it does not relate CR to any of the clinically invisible parts. This definition needs to be

modified to some extent to describe the centric relation correctly and the quest to define CR can end.

Proposed Definition

> "Centric jaw relation is the most retruded position of the mandible to the maxillae at an established vertical dimension which is repeatable and recordable."

Centric relation is being discussed under the heading of jaw relations so it is logical to discuss it in relation to maxilla and mandible rather than the head of condyles and its position. This new definition eliminates the most confusing controversial part of the position of the head of the condyle in the glenoid fossa and also does not relate CR to any of the clinically invisible parts such as head of the condyle, articular disk, glenoid fossa, slopes (shapes) of articular eminence etc. and it very effectively serves our primary aim of explaining the maxillo-mandibular relationship without creating any confusion. This definition is simple and self explanatory. The reason to relate CR definition with head of the condyle and its position in the glenoid fossa by almost all the researchers' may be because Hanau in 1929 was the first to refer to the condylar position in relation to CR and everyone followed it till date. This research has gone to such an extent that the position of the mandible in relation to maxilla is not mentioned in some of the definitions while defining CR.

Conclusion

Definition of CR has evolved over the years. With greater understanding of the mandibular movements the concept of antero-superior position of the head of the condyle may change again in future. Definition of CR needs to be clinically oriented, to lessen the confusion and controversies, by eliminating clinically invisible parts from the definition. The clinician can be confident about his CR recording and understanding which in turn shall be helpful in his ability to plan several treatment procedures.

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