

Techniques to Guide the Mandible to Centric Relation- A Systematic Review

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ABSTRACT

Introduction: Centric Relation (CR) is the only physiological position which is repeatable, recordable and reproducible for prosthodontic rehabilitation. A missed CR can give rise to faulty occlusal relationships leading to a life time of trauma to the temporomandibular joints. Literature has various methods outlined to locate and record the CR but it's confusing as to which method is best suited to take the condyles into CR position. Hence, this systematic review was conducted to find an answer to this very question.

Aim: To find a reliable clinical technique to guide the mandible to a recordable, repeatable and reproducible CR position.

Materials and Methods: The present systematic review was conducted from July 2019 to October 2019 at School of Dental Sciences, KIMSDU, Maharashtra. A 20-year comprehensive literature review was undertaken aiming to arrive at a reliable and repeatable method to guide the mandible to CR following the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) and Patient Intervention Comparison Outcome (PICO) guidelines to the highest possible extent. The research material was sifted through MEDLINE (PubMed)-{"CR technique"} (MeSH terms) AND/OR (Retruded mandibular position") (MeSH terms)}, Cochrane library "CR techniques" and Google Scholar "CR techniques OR Retruded mandibular

position" search engines. Cochrane collaboration tool was used to assess the risk of bias for the Randomised Controlled Trial, Methodological I index for non RCTs (MINOR). Quality and strength of the existing evidence was appraised by both the authors through Grading of Recommendations Assessment, Development and Evaluation (GRADE) system.

Results: Online database search was conducted from January 1998 to September 2019 resulting in a total of 950 articles being shortlisted. Post-screenings, using the exclusion criteria, nine articles of the total articles were reviewed. These were reviewed individually by both the authors and discussed for various techniques to guide the mandible to CR. The ultimate outcome of the review was that the clinicians are required to fall back on time tested models, scientifically sound and technically correct and uncomplicated to execute methods which have proven to yield the most excellent outcomes at zero or minimal cost. One such method is undoubtedly Dawson's Bimanual Technique. Bimanual technique in supine position coupled with a simple anterior deprogrammer has consistently resulted in a physiological CR position that is recordable, repeatable and reproducible.

Conclusion: The primary outcome of this systematic review is that Dawson's bimanual manipulation technique is superior to other techniques; primarily when carried out in supine position.

Keywords: Centric occlusion, Condyle, Retruded mandibular position, Temporomandibular joints

INTRODUCTION

Being the only repeatable, reproducible and recordable position to fabricate prosthesis, CR has an irreducible clinical perspective [1]. Clinically, this is the utmost accommodating and unstrained position of the mandible [2]. The concept of CR can find its genesis in the need for a reproducible physiological mandibular position without inimical ramifications on the Temporomandibular Joint (TMJ) emanating into prosthodontic rehabilitation. CR is used as the outset for fabrication of complete dentures; full mouth rehabilitation cases either with implants or Fixed Dental Prosthesis (FDPs) or distal extension Cast Partial Dentures (CPDs) for occlusal restoration [2,3]. Further; a missed CR can result in erroneous restorations/ prosthesis leading to deficiency in prosthodontic treatment [4,5]. Since the inception of CR more than a century ago, various aspects related to it such as its definition, methods to register and materials to record CR have all seen constant change. Each of these has advocates and critics alike [6-8].

The most recent Glossary of Prosthodontic Terms (GPT 9) defines CR as "a 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; from this unstrained, physiologic, maxillo-mandibular relationship, the patient can make vertical, lateral or protrusive movements; it is a clinically useful, repeatable reference position"[9]. To state simply,

it is a relationship of the maxilla to mandible in a horizontal plane or antero-posterior direction [10].

Techniques to guide the mandible to CR, the topic of this paper, have also seen a number of different expert views and experiments on the fruition and success of different approaches. Worth mentioning here are chin point guidance, swallowing, dawson's bimanual technique, Tongue tip to palate etc., [6-8,11]. Many research projects have also been conducted to compare several of these techniques [4, 12-23]. Various techniques to guide the mandible to CR have also been described in textbooks [2,3,24]. Unfortunately, none of them have been able to culminate on an evidence based single technique with acceptable levels of repeatability and reliability [4,6-8, 13,25]. Hence, this systematic review has been taken up as an attempt to provide an evidence based answer to fill this lacuna.

MATERIALS AND METHODS

The present systematic review was performed spanning 20 years from January 1998 to September 2019 and reviewed from July 2019 to October 2019, the last search was done on 31st October 2019 at School of Dental Sciences, KIMSDU, Maharashtra following the PRISMA and Population, Intervention, Control and Outcomes (PICO) guidelines [26].

The review focussed mainly on finding a reliable technique/s to guide the mandible to CR position. The review has not been registered.

Research question: Questions relating to PICO were generated to systematically review the available literature. With regards to the study population (P), randomised controlled trials which considered healthy dentulous, partially edentulous, and completely edentulous patients with no clinical signs and symptoms of TMJ disorder and oro-facial abnormalities were included. To answer the other questions of PICO, clinical techniques to guide the mandible to CR (I), studies comparing two or more techniques to guide the mandible to CR (C) were considered. Repeatable, reproducible and recordable CR position was considered as the outcome (O).

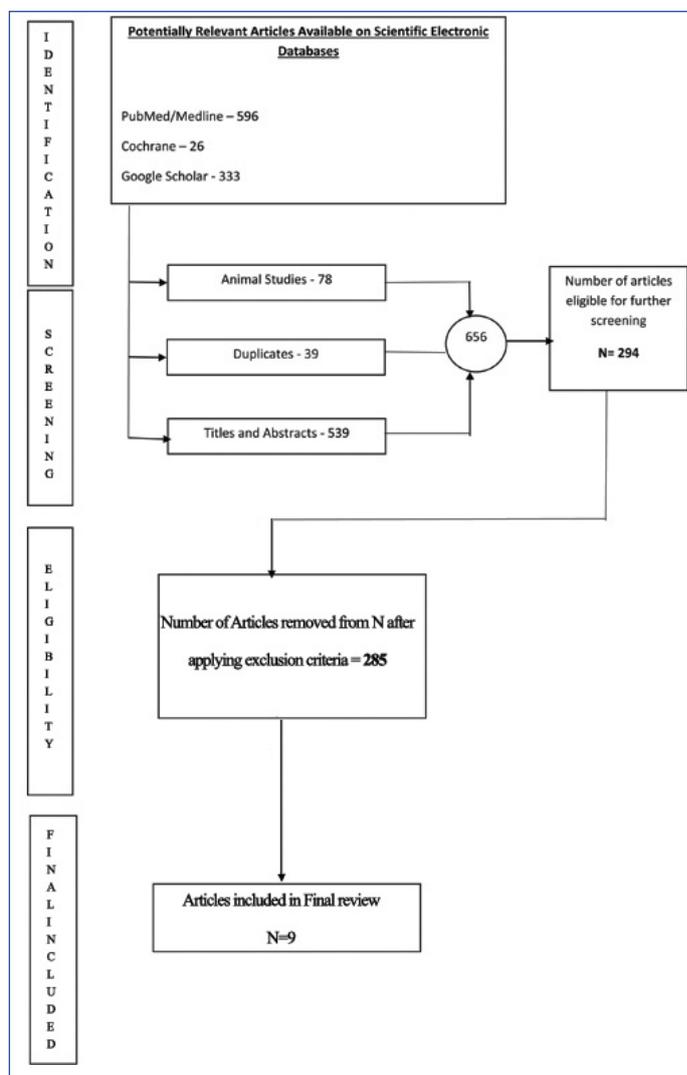
Search strategy: The research material was sifted through MEDLINE (PubMed)-{("Centric Relation technique") (MeSH terms) AND/OR (Retruded mandibular position") (MeSH terms)}, Cochrane library "Centric relation techniques" and Google Scholar "Centric relation techniques OR Retruded mandibular position" search engines.

The detailed systematic search strategy is presented in [Table/Fig-1]. The search yielded a total of 958 articles of which were 78 animals related and 39 duplicate studies were removed leaving a total of 833 for further screening. A total of 539 studies were dropped after studying their titles and abstracts as they did not fit the scope of this review leaving 294 for additional scrutiny.

Focus question	To find a reliable technique to guide the mandible to Centric Relation (CR) position amongst the various clinical techniques
Search strategy	
Population	Healthy dentulous, partially edentulous and/or completely edentulous patients.
Intervention	Guiding the mandible to Centric Relation (CR) position.
Comparison	Comparison of various clinical techniques to guide the mandible to Centric Relation (CR) position.
Outcome	Recordable, repeatable, reproducible Centric Relation (CR) position.
Search terms	PubMed - ("Centric Relation technique") (MeSH terms) AND/OR (Retruded mandibular position") (MeSH terms) Cochrane Library - "Centric Relation techniques" Google Scholar - "Centric Relation techniques OR Retruded mandibular position"
Data search electronic database use	MEDLINE (PubMed), Cochrane Library, Google Scholar
Time frame	January 1998 September 2019.
Selection inclusion criteria	
Inclusion criteria	Articles in English Language Studies on clinical methods of retruding the mandible. Comparative clinical studies done on healthy dentulous, partially edentulous, completely edentulous patients. Comparative studies on patients with no clinical signs of TMD's Comparative studies on patients with no clinical signs of Orofacial abnormalities
Selection exclusion criteria	
Exclusion criteria	Non English Language articles Surveys Animal studies In-vitro studies Ex-vivo studies Radiographic studies Electro-myographical studies Orthodontic studies Centric Relation (CR) studies related to dental implant CR studies on patients with clinical evidence of TMD's CR studies on patients with clinical evidence of Orofacial abnormalities

[Table/Fig-1]: Systematic search strategy. TMD: Temporomandibular diseases

Further down in the process, 285 articles were excluded based on the exclusion criteria. The PRISMA flow diagram for shortlisting the articles have been shown in [Table/Fig-2].



[Table/Fig-2]: PRISMA flow chart for article selection.

These nine studies were then methodically checked to avoid any probability of discrepancies creeping up at a later stage in the review [12,14-18,23,27,28].

Once all and any uncertainties and doubts were laid to rest the actual systematic review was undertaken. Eligibility of the relevant articles to be included in the systematic review was verified independently by two authors of this study. Any disagreement was resolved over discussion with the third reviewer. The screening of the titles and abstracts were done to clarify whether or not the articles were fit for further reading. At the end, a thorough hand search of the selected articles was conducted and the articles which were missed out were added. Within each included study, the following items; name of the author/s, publication date, sample size, mandibular guiding techniques compared were recorded.

Risk of bias assessment: Cochrane collaboration tool was used to assess the risk of bias for the RCT's and MINOR index for non RCT's [29,30]. A statistical comparison of results and a meta-analysis was beyond the scope of this systematic review due to the diversity of the study population, sample size, study settings. The quality and strength of the existing evidence was appraised by both the authors through GRADE system [31].

RESULTS

The selected number of articles which finally fit into the parameters of the focal question were nine [Table/Fig-3]. which describes the exhaustive rundown of the selected nine articles [12,14-18,23,27,28].

[Table/Fig-4] shows the risk of bias in the studies using Cochrane collaboration tool [12,14-18,23,27,28].

Author and Year	Materials and methods	Compared techniques (for guiding mandible in CR)	Results	Conclusion	Interpretation
Kandasamy S et al., [12] (2013)	Total 19 healthy participants with permanent dentition (14 men and five women) of 20-39 years of age were recruited for the study.	Comparison between <ul style="list-style-type: none"> CR (by applying distal pressure to the chin) and CO (biting together in maximum intercuspation) CR and CO using Roth Power technique. CR (by applying distal pressure to the chin) and CR (Roth Power technique) Both the antero- posterior and supero-inferior condylar positions for the condyles in all the above mentioned positions (CO, CR) were measured in the MRI scan.	There was no statistically significant difference between the measurements. Authors claim that asymmetric and opposite changes were noted between left and right condyles.	There was no statistically significant difference between the techniques.	Both bimanual manipulation technique and Roth power technique places the mandible accurately in CR position.
Keshavd A and Winstanley RB et al., [14] (2003)	Total number of patients: 14 (average age 26.61±4.20 years and having complete dentition.)	<ul style="list-style-type: none"> Bimanual mandibular manipulation with a jig, Chin point guidance with jig Active (Unguided) Gothic arch tracing by asking the patient to carry out excursive movements. Casts were mounted on Denar D4A by means of facebow and maximum intercuspation silicone registration record. Mandibular positional indicator was constructed for the positional analysis of condyles in three spatial axis.	Bimanual manipulation was more consistent showing between 10.11 and 0.438 times less variation than the gothic arch method which was the least consistent method. Chin point guidance was in between the other two method	Bimanual mandibular manipulation used with an anterior jig gave the highest repeatability. Bilateral TMJ showed different degrees of repeatability with each of three CR records.	Bimanual manipulation with an anterior jig was the most accurate technique in terms of placing condyles in CR position repeatedly.
Mckee JR [15] (2005)	Total 11 dentists without any TMJ disorders were recruited for the study. CR records were made for each dentist by other three participant dentists. Thus three records (wax) for all the 11 dentists were made. Anterior deprogrammers were made for each participant which was worn for 60 minutes. Then, each participant of the group had four different interocclusal wax records. (three in reclined position and one in Upright position.)	Compared condylar position obtained by bimanual manipulation with the condylar position obtained from interocclusal records using muscle contraction against anterior deprogrammer with the use of condylar position indicating device.	The condylar positions recorded using bimanual manipulation repeated the condylar position within 0.11mm tolerance of the centric check instrument in 100% of the cases while The condylar position recorded using muscle deprogrammer repeated the condylar position within 0.11mm tolerance of the centric check instrument in 97.7% of the cases.	Concluded that condylar position obtained through both the techniques were similar.	Both bimanual manipulation technique and muscle contraction against anterior deprogrammer places the mandible accurately in CR position.
Celar A et al., [16] (2013)	Total 37 healthy participants (19 men 18 women) aged 23-32 years with complete dentition without the third molars were chosen for the study.	Compared the bimanual operator guidance and unguided mandibular stationary hinging at final jaw closure. Electronic condylar position indicator measured the position of the condylar spheres with six measuring gauges that displayed XYZ spatial coordinates of the left and right condylar positions.	In the sagittal plane: <ol style="list-style-type: none"> On the left- both BM (bimanual position) and NM (Non manipulation) was located posterior and inferior to intercuspal position ICP. On the right: For the BM the condyles were positioned posterior and inferior to ICP and for NM the condyles were positioned, Anterior and Inferior compared to ICP. BM was not significantly different from ICP. NM was significantly more caudal than ICP. BM and NM differed significantly in all directions except antero-posteriorly on the right side. 	Concluded that there was statistical but not clinically relevant difference between the repeatability of the two methods.	Both bimanual operator guidance and unguided mandibular stationary hinging have similar accuracy.
Kazanji M et al., [17] (2014).	Total 30 edentulous patients aged between 45-65 years.	The 30 patients were divided into three groups according to the method of guiding to CR applied <ul style="list-style-type: none"> Group A: Swallowing method Group B: Chin point guidance was used. Group three: Bimanual manipulation was used to guide the mandible into CR. 	There was no significant difference in the mean of the different methods,	Bimanual manipulation method was found to be the most repeatable technique with least variations.	Bimanual manipulation method was the most repeatable technique with least variations.
Sushma R et al., [18] (2019)	Total 60 completely edentulous patients. Group 1 had 19 male and 11 female participants Group 2 had 17 male and 13 female participants. The average age of participants in group 1 was 58.33±11.874 years and for group 2 it was 61.17±12.157 years	Total 60 patients were divided into two groups depending on the method applied to retrude the mandible into CR. <ul style="list-style-type: none"> Group 1: A new technique: wax ball technique was used to retrude the mandible. Group 2: Dawson's bimanual method was used to retrude the mandible. The time taken to register the CR in both the techniques and the accuracy of both the techniques were compared in this study.	There was statistical difference in time taken between both the techniques but no statistical difference between the two techniques when accuracy was compared.	The mean time taken in group 1 was 56.47±75.368 years and mean time taken in group 2 was 5.97±2.042 years. Both the techniques were found to be accurate.	Both bimanual manipulation technique and new wax ball technique places the mandible accurately in CR position.

Alvarez MC et al., [23] (2009)	Total 10 patients aged 25 to 39 years were recruited for the study.	<ul style="list-style-type: none"> Compared swallowing technique with chin point guidance method. Compared swallowing technique with Bimanual manipulation 	<ol style="list-style-type: none"> There was no statistically significant difference among the methods for recording lateral displacement. Swallowing method differed significantly from other methods for anteroposterior (AP) displacement; however, there was no difference between chin point guidance and bimanual manipulation in the AP direction. 	Concluded that swallowing method produced smaller mandibular posterior displacements than the other methods.	Both bimanual manipulation technique and chin point guidance technique place the mandible accurately in CR position.
Watanabe Y [27] (1999)	Total number of patients: 26. Group A (N=16) had maxillary edentulous ridges and lower partially edentulous arches. Group B (N= 10) had both maxillary and mandibular edentulous arches. Tracers attached to the lower arches had sensors attached to it and the readings were recorded real time in computer.	<ul style="list-style-type: none"> Active (Unguided) Gothic arch tracing in upright and supine position Light Guide Tapping Position (LGTP) in upright and supine position. Bimanual manipulation in upright and supine position. 	Both in Group A and B, the LGTP were distributed 0.2 to 0 mm anterior and 0.02 mm lateral to the bilateral manipulation. A variation range of 0 to 0.6 mm was found in both the bilateral manipulation and LGPT. Approximately 60-80% of the variation was within 0.2mm in the anteroposterior and lateral direction.	<ul style="list-style-type: none"> Supine position is better for recording CR. CR recorded by unguided Gothic arch tracing matches the CR recorded by bimanual manipulation in supine position. Although LGPT in upright position showed variable results; in supine position it matched closely with that of bimanual manipulation and gothic arch tracing. 	Bimanual manipulation technique primarily in supine position gave better results than other techniques.
Millet C et al., [28] (2003)	Total 15 healthy subjects (six men and nine women) between 45 to 81 years (mean age of 63± years).	<ul style="list-style-type: none"> Compared bimanual manipulation and swallowing method to record the CR Compared swallowing and traditional technique (Niswonger's method) to record vertical dimension and CR 	The mandibular position in the sagittal plane during swallowing was significantly more anterior than CR in all subjects. The VDO determined with the swallowing technique was 21.8± 1.6 mm. VDO obtained by means of the traditional method was 20.0±0.5 mm. The VDO determined with the swallowing method was statistically higher (1.8 mm) than the VDO obtained with the traditional method.	<ul style="list-style-type: none"> CR position obtained with swallowing technique place mandible more anterior compared to bimanual manipulation technique. Swallowing technique is not recommended to record CR VDO obtained with swallowing is higher (1.8mm) than VDO obtained with traditional technique. Swallowing technique can be used to record the VDO. 	Bimanual manipulation technique gave better results than other techniques.

[Table/Fig-3]: Studies included in the systematic review.

CR: Centric relation; CO: Centric occlusion; TMJ: Temporomandibular joint; ICP: Intercuspal position; VDO: Vertical dimension of occlusion, MRI: Magnetic resonance imaging

	D1	D2	D3	D4	D5	Overall
Kandsamy S 2013 [12]	+	+	-	+	+	+
Keshvad A and Winstanley RB [14]	+	+	+	+	+	+
Mckee JR 2005 [15]	+	+	+	+	+	+
Celar A 2013 [16]	+	+	+	+	+	+
Kazanji M 2014 [17]	+	+	+	+	+	+
Sushma R 2019 [18]	+	+	+	+	+	+
Alvarez MC 2009 [23]	+	+	+	+	+	+
Watanbe Y 1999 [27]	+	-	+	+	+	+
Millet C JR 2003 [28]	+	-	+	+	+	+

Domains:
D1: Bias due to Randomisation
D2: Bias due to deviation from intended intervention.
D3: Bias due to missing data
D4: Bias due to outcome measurement.
D5: Bias due to selection of reported result.

 -> Low Risk of Bias
 -> Some

[Table/Fig-4]: Risk of bias assessment.

DISCUSSION

The present systematic review was designed to identify published articles comparing the diverse techniques for guiding the mandible

to CR position. Nine articles included for this review were all original studies, done in a clinical setup, comparing two or more techniques to guide the mandible to CR position.

The patients recruited in all the studies were healthy individuals, without any TMJ disorders or deformities in oral and maxillofacial region. Of the nine selected articles, four articles studied edentulous patients while the other five articles did examination on dentulous patients. A total of 222 subjects had participated in these nine studies, of which 115 patients were entirely edentulous and 16 were partially edentulous; while remaining 91 were dentulous.

Watanabe Y loaded the horizontal position data on a personal computer with the help of sensors attached to the gothic arch tracing. CR position obtained with excursive mandibular movements and recorded with gothic arch tracing, bimanual manipulation and chin point guidance in both supine and upright positions. From this comparison, it was inferred that bimanual manipulation technique in supine position gave reliable and repeatable results [27]. Comparable results were obtained in the study done by Keshvad A and Winstanley R where bimanual manipulation, chin point guidance with a jig and gothic arch tracing were compared. Bimanual manipulation was found to be a superior technique when used along with anterior jig in all three axis, while gothic arch tracing was the least repeatable [14].

The anterior deprogrammer is a flat plane occlusal splint with an anterior acrylic block designed to disocclude the posterior teeth. It eliminates the patient's neuromuscular avoidance mechanism and

helps him/her to acquire CR position without assistance. The use of the deprogrammer and the action of the elevator muscles allow seating of the condyles in an anterior-superior position [32]. An anterior programming device helps separation of the posterior teeth immediately prior to CR record fabrication which helps in the patient "forgetting" the established protective reflexes. Cotton rolls, plastic leaf gauge, oral small device made of autopolymerising acrylic resin placed between the maxillary and mandibular anterior teeth can be used as an anterior deprogramming device [33]. This results in an anterior stop that acts as a fulcrum which directs the force provided by the elevator muscles to seat the condyles in CR position. This coupled with the Dawson's bilateral mandibular manipulation technique has shown to result in a greater mandibular displacement from the intercuspal position than with a CR record alone. It turns the rigid muscles of a 'clencher' to butter [33-35].

In the study done by Millet C et al., swallowing technique was used as a technique to record both vertical and horizontal jaw relation and was compared to bimanual manipulation technique. It was noted that swallowing provides an occlusal zone and not merely a single position and hence cannot be used as a reference position in sagittal plane to record the CR position [28].

In his study, McKee JR compared the position of condyles achieved by Dawson's bimanual manipulation and masticatory muscle contraction against an anterior deprogrammer with the help of condylar position indicating device. Condylar position achieved by both the techniques against an anterior deprogrammer was the same, when there were no influences from occluding teeth [15].

Another study included in this systematic review compared intermaxillary relationships with manual (chin point guidance), swallowing and bimanual methods by Alvarez MC et al., [23]. There was no significant difference found between chin point guidance and bimanual manipulation. However; there was a significant inference that, when used in combination with anterior jig or leaf gauge, all methods guide the mandibular condyles to the CR position. Among the three techniques evaluated, it was found that swallowing technique was dependent on patient and could cause inaccurate position in presence of occlusal interference. Celar A et al., studied guided and unguided mandibular positions in asymptomatic patients. Bimanual manipulation was compared to unguided jaw closure with reference to spatial relationship of condyle positions, repeatability over time and operator influence. The Non Manipulated (NM) technique placed condyle about 0.6 mm (average) anterior and inferior to the position obtained by bimanual manipulation. The differences in position were within tolerance of biological system. Proper exercise and guidance to the patient prior to recording the centric position resulted in almost similar reproducibility in both the techniques [16].

Kandasamy S et al., assessed condylar position by Magnetic Resonance Imaging (MRI) after common bite registrations; centric occlusion, retruded CR and roth-power CR. The study failed to sustain the claim that certain bite registrations could accurately position the condyles in specific position in glenoid fossa [12]. Kazanji M et al., at checking reproducibility of three different techniques: bimanual manipulation, swallowing and chin point guidance. All the three techniques gave acceptable results however; the bimanual manipulation technique gave the most repeatable and reproducible result [17].

Sushma R et al., in a recent study compared bimanual manipulation technique with a new copyrighted technique (wax ball orientation technique). The technique involved a modification of the record base wherein three orientation wax balls were fabricated on the record base; one behind the incisive papilla, the second one in line with the premolar region and the last one at the posterior border of the record base near the posterior palatal seal region in line with the second molars. Patients were trained initially and once they were comfortable with the technique, were asked to touch the tip of

the tongue to posterior most orientation wax ball and close on the occlusal rims thus guiding the mandible to CR. The two techniques were compared based on timings required to record CR accuracy. It was found that both techniques recorded CR accurately with insignificant difference between the two techniques. Also, the wax ball orientation technique required significantly lesser time than the bimanual manipulation technique to record CR [18].

Bimanual manipulation technique: Among the nine studies included in this systematic review, 8 studies compared bimanual manipulation technique with one or two other techniques. This passive technique of recording CR was described by Long JH and then modified and popularized by Peter Dawson [36,37]. Bimanual manipulation is considered as an accurate and reliable method for placing condyle in glenoid fossa in CR position by many researchers [15,18,19]. Further, some studies observed that this technique gave the most reproducible and repeatable results [8,14,23]. The results of six studies reported in this systematic review concluded that bimanual manipulation technique was better than the other compared techniques.

In this technique, the dental chair is reclined and the patient's head is cradled by the examiner. With the help of both thumbs on the chin and the fingers resting firmly on the inferior border of the mandible, downward pressure is exerted by the examiners thumb and upwards pressure on the fingers thereby manipulating the condyle-disk assembly in their fully seated positions in the mandibular fossae, after which the mandible is carefully hinged along the arc of terminal hinge closure [37]. Dawson claims bilateral manipulation is the only appropriate method to position the mandible in CR. In one of his studies, it was established that more than 3000 dentists preferred bilateral manipulation technique [38].

This technique positions the mandible posteriorly while concurrently directing force supero-anteriorly on the condyles providing:

- A swift corroboration of correctness of the position.
- Alignment of condyle-disk assembly.
- Integrity of articular surfaces, all the while being quick and straightforward.

This goes on to show the pre eminence of this technique over the other jaw manipulation methods. Once the correct skills are acquired, the CR position can typically be located and verified within a few seconds, all the while giving the operator excellent control over jaw movement [37,38].

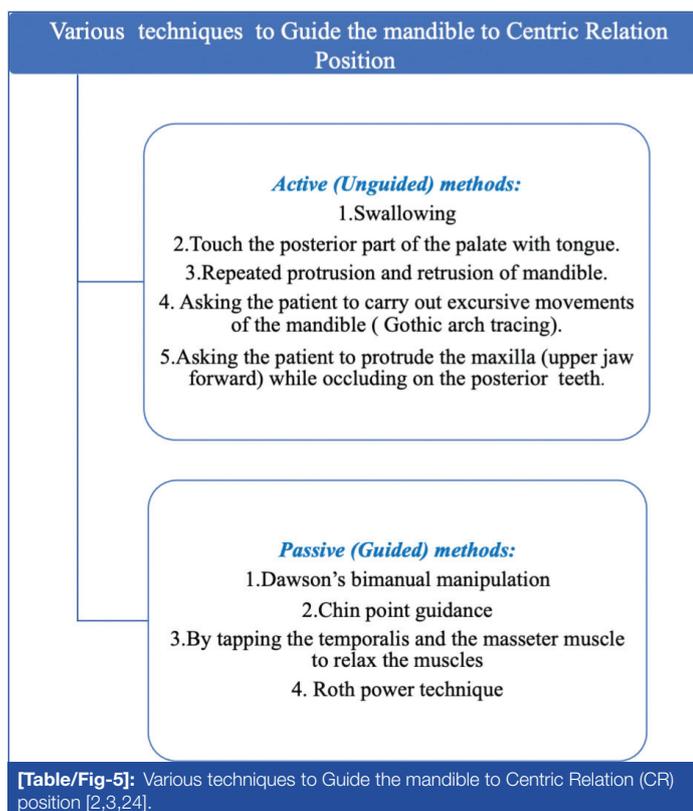
Chin point guidance is a passive method of recording CR described by Ramfjord and Ashand, Ash and Ramfjord, and first reported in literature by McCollum BB [39]. Previously, it was also called as "3 Finger" method as the thumb, index finger and middle finger were all placed on the chin and the mandible was pushed as far posterior as possible. The method was then modified with the thumb placed on the middle of chin and the other two fingers supporting the mandible inferiorly [14]. According to Keshavd A and Winstanley RB, Alvarez MC et al., Watanabe Y, chin point guidance technique could be used for recording CR with almost similar accuracy as that of bimanual method [14,23,27].

Swallowing is an active method of guiding the mandible to CR [40]. Niswonger mentioned that during swallowing mandible travels from rest position to CR and back to the rest position [6]. Kurth LE used the swallowing reflex in determining CR [22]. Swallowing or free closure technique was advocated by Shanhan TEJ [41]. While some authors advocate the swallowing technique for recording CR, few others state that CR differs from a swallowing position [6,41-43]. Numerous studies conclude that while swallowing the mandible never moves back to the terminal hinge position but remain slightly anterior to it [23,31,44,45]. Conversely, a minority of studies question the applicability of the swallowing technique for guiding the mandible to CR principally because of the various results it produces [3,23,28].

Gothic arch technique: Gothic arch technique was used in two of the studies done by Keshavd A and Winstanley RB and Watanabe Y [14,27]. Arrow point tracing or needle-point tracing or gothic arch tracing is an active method of guiding mandible to CR and was first introduced and popularised by Gysi [6]. Gysi developed this method as an extraoral tracing technique which was later modified by Gerber et al., to an intraoral technique both having their own advantages and disadvantages. In this technique, the CR registration was not considered correct until the apex of the tracing was sharp and thin [40].

Power centric bite registration by Roth RH otherwise known as the Roth power technique is “a two-piece wax registration method”. It is understood to place the condyle in the optimal anterior superior CR position. In this technique patient’s own musculature is utilised to guide the mandible into CR when resistance is applied in the anterior region [46]. It is recorded with a 2- piece wax registration consisting of anterior and posterior sections. The anterior section is first constructed at a vertical vis-à-vis the posterior teeth, at least 2 mm apart. This piece of wax is frozen and allowed to harden. The wax is then placed back into the mouth after which a softened posterior section is positioned, and the patient is instructed to bite. The mandibular anterior teeth are guided into the toughened anterior section of wax without a slide in the indentations. As the patient closes onto the hardened anterior section, he or she is instructed to “close firmly and clutch.” When the posterior section which is chilled with air hardens sufficiently to prevent distortion, both wax sections are then removed and chilled [47].

Active vs Passive techniques [Table/Fig-5]: According to some researchers, active (unguided) method of guiding mandible to CR is superior to passive (guided) method. However; the supporters of passive method agree that pressure for guiding the mandible should not be heavy as it causes discomfort to the patients resulting in muscular activity for self-protection leading to protrusion of lower jaw [6,20,21]. On the contrary, the articles reviewed in this systematic review observed that the most repeatable technique to record CR is bimanual manipulation which is a passive method.



Strength of this systematic review: This systematic review addresses one of the most contentious topics in dentistry in general and prosthodontics in particular. In spite of the availability of rich literature, there always has been a pertinent question as to which is

the best method to guide the mandible to CR. This review addresses that question using the PICO format. The data extraction was charted out clearly and performed independently by two authors and any discrepancy found was resolved by consulting the third author. Though the general consensus seems to direct the choice of technique on numerous factors such as clinician’s judgement, expertise, experience and patient related factors, this review points at one particular evidence-based technique being far more superior to others considering the repeatability, reliability and outcome.

Limitation(s)

Firstly, the time frame selected for this systematic review was pretty long i.e. 20 years while only 9 articles could be selected for the review after the application of all the required criteria. The other limitation of the study was that a meta-analysis could not be conducted because of variations in the study population, sample size, study settings. Also, the number of patients allocated in each study was less for application on a large population. Hence, there is a scope to study the different technique to prove the superiority on a large population.

CONCLUSION(S)

The primary outcome of this systematic review is that Dawson’s bimanual manipulation technique is better than other techniques especially when carried out in supine position. Irrespective of the technique used to guide the mandible to CR, clinicians should prefer supine position over an upright position. Muscle deprogramming with anterior jig or leaf gauge before guiding the mandible to CR gives superior results. At the bleeding edge of technology, the science of dentistry is being shaped and reshaped at a break neck speed and Prosthodontics is no exception. Innovations in diagnostics, advances in material sciences, and sophistication in biomedical engineering has ushered in a new dawn in the field of dentistry. The nascent stages of some of these advancements also bring in the burden of elevated costs for both clinicians and patients. Some developments stay prohibitively expensive for a long time for them to be accepted as a part of main stream treatment methodology, especially so in the developing and under developed countries.

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