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Original Article

Dentistry Section

Clinical, Electromyographical and Radiological Comparison of Dawson's Bimanual Technique of Guiding the Mandible with Wax Ball Orientation Technique©

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ABSTRACT

Introduction: There are numerous methods to guide the mandible into Centric Relation (CR). The Dawson's bimanual technique is a time tested and established method to guide the mandible into CR. On the other hand the author of the present study also has copyrighted a technique (wax ball orientation technique©) to guide the mandible into CR. Hence, this methodological study was performed to compare the two CR techniques to guide the mandible in CR position using clinical, myographical and radiological assessment methods.

Aim: To compare and assess which amongst the two (Dawson's bimanual techniques, and wax ball orientation technique) CR guiding techniques best guides the mandible to CR position using clinical, electromyographical and radiological assessment methods.

Materials and Methods: This interventional and clinical study was conducted at School of Dental Sciences, KIMSDU, Karad, Maharashtra, India, from May 2019 to May 2020. The study included healthy dentate individuals having Angle's class I malocclusion without any occlusal interferences and an intact dentition except for 3rd molars. Two CR technique to guide the mandible were technique 1-Dawson's bimanual technique and technique 2- wax ball orientation technique. The study was carried out in three phases: clinical, electromyographical and radiological. Difference between the centric points, workload on elevators, condylar position was statistically analysed. Descriptive statistics was used to analyse the difference between the centric points marked using both the techniques. Independent t-test was applied to compare the gender and the mean centric distribution.

Results: Among the 45 study subjects considered for the study, 32 were females and 13 were males with the mean age of 21 years. No statistically significance difference was observed between the two techniques. Paired t-test showed that workload on elevators of both sides, Right Masseter in technique 1 and 2 had p-value=0.088, left Masseter in technique 1 and 2 had p-value=0.3, Right temporalis in technique 1 and 2 had p-value=0.463, left temporalis in technique 1 and 2 had p-value=0.429. There was difference between the Anteroposterior (AP) and Superoinferior (SI) position of condyle in relation to the fossa. AP measurement in the right side in tech 1 and 2 with p-value=0.448, AP measurement in the left side in tech 1 and 2 with p-value=0.178, SI measurement in the right side in tech 1 and 2 had p-value=0.803, SI measurement in the left side in tech 1 and 2 had p-value=0.259, which were statistically insignificant. Multivariate test showed statistically significant difference between gender and EMG, results whereas it was insignificant in Magnetic Resonance Imaging (MRI).

Conclusion: The wax ball technique has similar accuracy as the Dawson's Bimanual technique.

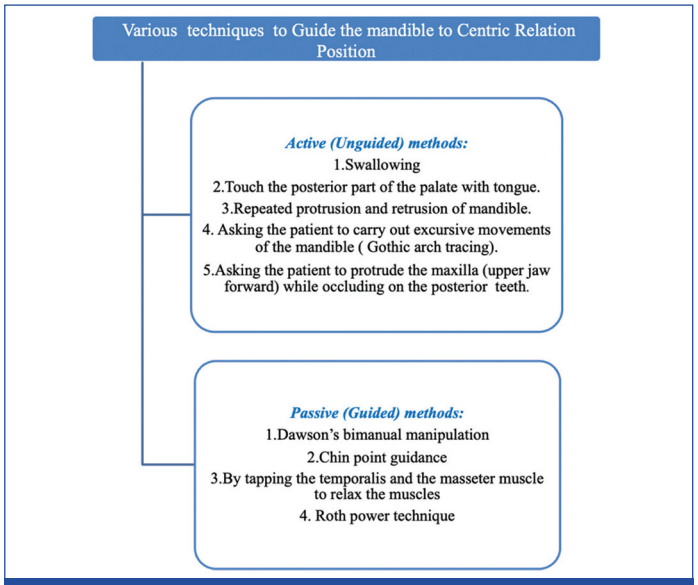
Keywords: Centric relation, Condyle, Magnetic resonance imaging, Masseter, Temporalis, Temporomandibular joint

INTRODUCTION

The Centric Relation (CR) is the classic position of the maxillomandibular relationship for the prosthetic rehabilitation. CR position is independent of tooth contact, clinically discernible when the mandible is moved anteriorly and superiorly and is restricted to a purely rotary movement around the transvers horizontal axis [1]. CR has a long and substantial history and has been a topic of contention for over a century [2]. However, the recent most definition was given by the Glossary of Prosthodontics (GPT) 9 [3] in 2017. Copious literature is available on a variety of guiding techniques to achieve CR each with its own advantages and disadvantages [4-19]. For convenience sake the authors have given a simplified classification of the various methods of guiding the mandible to CR in their systematic review on CR [20] [Table/Fig-1].

Centric relation is a bone-to-bone relationship [21]. Various imaging techniques can be used to assess the spatial relationship of condylar disc assembly in CR [22]. However, magnetic resonance imaging is undoubtedly the safest, precise and reliable method to identify the exact position of the condyle-fossa relation [23].

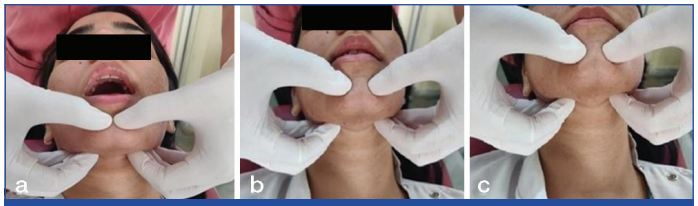
More recently, the focus has shifted to CR being described as an anatomic-physiologic relationship [24]. Over the last three decades



[Table/Fig-1]: Various techniques to guide the mandible to Centric Relation (CR) position.

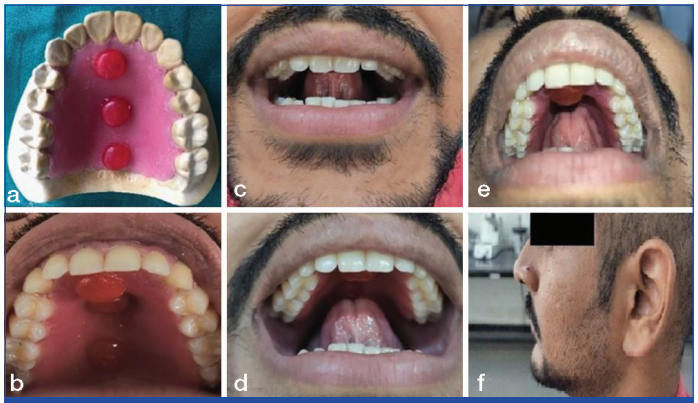
the biological aspects of CR has taken over the mechanical aspect and various authors have contributed to the literature [25,26]. The muscles of mastication play a vital role in a whole quarantine of Temporomandibular Joint (TMJ), occlusion and the elevator muscles, especially the masseter and temporalis. Muscle activity during various jaw positions can be defined by Electromyography (EMG) [25]. EMG activities in CR and Maximum Intercuspation (MI) have been described in details by the works of Buxbaum J et al., [26].

Dawson's bimanual technique: In Dawson's bimanual technique, the patient is in the reclined position and the patient's head is cradled by the operator [Table/Fig-2a-c]. 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 [20].



[Table/Fig-2]: a-c) Dawson's bimanual technique.

Wax ball technique: it is a new technique where in tongue guides the mandible to CR. After establishing the vertical jaw relation, three orientation balls made of modeling wax are placed to the upper record base and along the midline. The wax balls are placed as shown in [Table/Fig-3]. The operator gives instruction to the patient as to when they must place their tongue on those fabricated balls. The main advantage of this new technique is that it is easy for the patient to understand and follow the instructions of the operator and simulate the tongue positions on the orientation wax balls thus retruding the mandible posteriorly. This technique is cost-effective and saves time of patients and operators [4].



[Table/Fig-3]: Record base modification and wax ball orientation technique.

The authors of the present study in an earlier paper have established that both the Dawson's bimanual and the wax ball orientation techniques are equally accurate and the time taken by the wax ball orientation technique© is significantly less compared to the Dawson's technique [4]. This finding led the authors to device a study with a purpose to compare and assess which amongst the two CR guiding techniques best guides the mandible to CR position using clinical using clinical, myographical and radiological assessment methods.

MATERIALS AND METHODS

This interventional and clinical study was conducted at School of Dental Sciences, KIMSDU, Karad, Maharashtra, India, from May 2019 to May 2020. Ethical clearance was obtained from Ethical Committee of Krishna Institute (KIMSDU/IEC/01/2018).

Inclusion and Exclusion criteria: Healthy dentate individuals having Angle's class I malocclusion without any occlusal interferences and intact dentition except for 3rd molars were included in the study. If any decayed, restored and/or missing teeth were found in the subjects, such participants were excluded from the study. Subjects with a history of orthodontic treatment, myofascial pain dysfunction disorder, tenderness in any muscles of mastication, TMJ disorders and with dental implants were also excluded from the study.

The participants had the protocols explained in English, Hindi and Marathi. Informed consent was obtained from each of them. The sample size (N=45) for the study was calculated in G Power Software using α as 0.05, power of the study 80% and medium effect size of 40%.

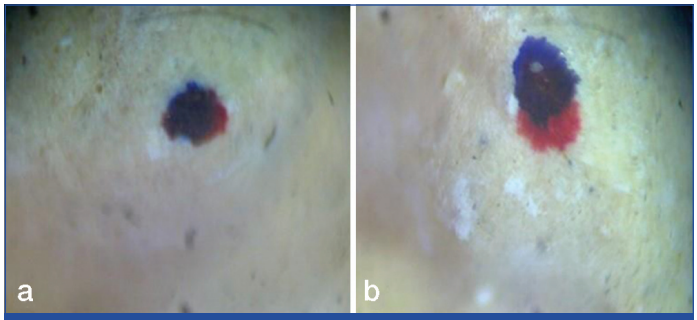
Three Phases of Methodology

1. Clinical phase: Hydrocolloid impression (3M ESPE alginate impression material, 3M India Ltd., Bangalore, India) of the maxillary and mandibular arches were made to obtain the casts (dental stone, Kalabhai Dental Pvt. Ltd., Mumbai, India). Maxillary casts were mounted onto a semi-adjustable articulator using face bow record (Bio art Semi adjustable articulator, Confident Sales India Pvt. Ltd., Bangalore, India).

Patients' mandible was guided to CR using technique 1 [Table/Fig-2], dawson's bimanual technique and technique 2 [Table/Fig-3] Wax ball orientation technique in consecutive appointments [3,18]. CR jigs and interocclusal records were fabricated as follows.

Jigs were fabricated using self-cure acrylic (cold cure, Dental Products of India Ltd., India). After applying petroleum jelly on the upper and the lower anterior teeth approximately 1×1 cm dough was placed on the upper central incisor and the mandible was guided to CR. The patient was hold in the CR position until the material set. Once fabricated, the jigs were cross checked for accuracy and fit, the CR records were made using addition silicone (3M ESPE Imprint, 3M India Ltd., Bangalore, India) with the jig in place. Once set the CR records were stored in a tight pouch for use during articulation, Magnetic Resonance Imaging (MRI) and EMG recordings.

The lower cast was articulated using the CR records fabricated using technique 1. The occlusal points were marked on the casts using 8 µ blue articulating paper (Artifol 8 microns, Bausch, Dr. Jean Bausch GmbH and Co. KG, Germany). The previously mounted lower cast using technique 1 was dismounted and the same lower cast remounted using the set of records fabricated using the technique 2. This time the occlusal points were marked using the 8 red articulating paper (Artifol 8 microns, Bausch, Dr. Jean Bausch GmbH and Co. KG, Germany). The casts were then demounted and preserved for later use. The lower cast now had two occlusal marks at the point of first contact (blue: technique 1 and red: technique 2). In some casts the marks coincided and in some two marks were distinct [Table/Fig-4a and b].



[Table/Fig-4a and b]: Clinical centric points on the cast coinciding and distinct.

For standardisation purpose, all the procedures were performed by a single investor. The CR jigs fabricated for both the techniques were stored in a container for later use during recordings of EMG and MRI. The containers were marked with the serial number to identify

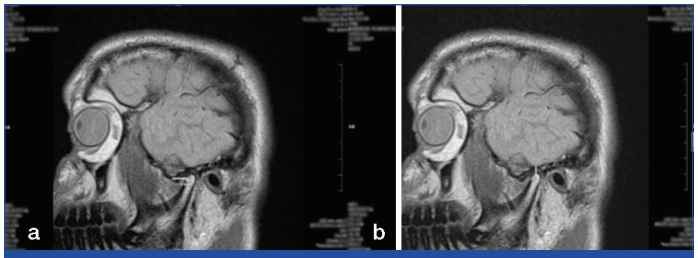
the study participants it belonged to. The CR jig for technique 1 was coded as 1, for technique 2 as 2 for that particular study participant. EMG and MRI were completed within hours of jig fabrication to avoid any dimensional changes in jigs.

The distance between the blue and red occlusal marking was recorded using the stereo microscope at 45 X (Z4 Zoom systems, Great scopes, High Point, North Caroline, USA). The images and the readings were transferred onto a computer for data analysis.

2. Electromyographic phase: After the clinical procedure, the study participants were subjected to EMG (Clarity EMG Octopus Machine, Clarity medica Pvt. Ltd., India) to record the readings of both the right and left temporalis and masseter muscles in CR positions. The EMG process was explained to the patient in detail. First jig (number 1) was placed in the patient's mouth, a ground electrode was placed on the forehead, the active electrode was placed on the centre of the maximum girth of the muscle and the third (indifferent electrode) was placed 3 cm away from the active electrode. Five readings of 2 seconds each in amplitude were taken in CR position. The average of the five readings was considered as the average amplitude for the participant. This procedure was repeated with the 2nd jig to record the readings of technique [Table/Fig-5].

[Table/Fig-5]: EMG Electrode placements and EMG readings for masseter and temporalis muscle.

3. Radiological phase: Magnetic resonance images were needed of the participants which were incurring by the university itself. The required MRI's were justified by the ethical committee. With each CR jig in mouth, condylar position against the respective fossae of both the condyles was assessed using same MRI scanner (Siemens Avanto 1.5 Telsa, Siemens Healthcare Pvt. Ltd., Mumbai, India), presumably the most accurate radiation free means of assessing 3-dimensional condyle disc fossa relationship. The detailed procedure of MRI scanning was explained to the study subjects. They were also informed about the chances of accidental discovery of anu orofacial abnormalities or pathologies. However; no pathologies were detected in any of the study subjects. The MRI scans of both the condyles were taken from the sagittal anatomical plane. Both T1 and T2 weighted images were made. The radiologist was blinded to the CR technique that he was assessing. On each side, measurements of the Anteroposterior (AP) and Superoinferior (SI) [Table/Fig-6] of the condyle with respect to the temporal bone was measured using the following cortical bony landmarks: 1) for the AP position, the anterior margin of the condyle and the summit of the articular eminence; 2) for the SI position, the highest point of the condyle and the deepest concavity of the glenoid fossa. The distance from the centre of the condyle to the above landmarks was analysed to check if the condyle positions (right and left) in CR for both techniques had any relation.



[Table/Fig-6a,b]: Magnetic resonance images reading in the Anteroposterior (AP) direction and Superoinferior (SI) direction. (Images from left to right)

STATISTICAL ANALYSIS

Data was entered into excel (Microsoft office, version 10.0) and analysed using IBM Statistical Package for the Social Sciences (SPSS) statistics for window, Version 23.0 Armonk, New York. Independent t-test was applied to compare the gender and the mean centric distribution. Paired t-test was used to analyse the work load on the masseter and temporalis of both right and left side in both the techniques. The AP and SI difference in the position of the condyle was analysed using paired t-test. Multivariate analysis was applied to compare the difference of EMG and MRI status in all groups of both genders.

RESULTS

Among the 45 study subjects considered for the study, 32 were females and 13 were males with the mean age of 21 years. The mandibular casts on which the centric points were marked were visualised under the stereo microscope at 45x magnification. In 26 casts out of the 45, the centric points coincided. The maximum distance detected in one sample was 539.17 µ [Table/Fig-7]. Amongst the 19 samples, the mean difference was found to be 174.1075 µ [Table/Fig-8]. Independent t-test was applied to compare the gender and the mean centric distribution, which showed no statistical difference with a p-value of 0.699 [Table/Fig-9].

Variables	N	Minimum	Maximum	Mean	Standard deviation
Centric distribution (µ)	45	0	539.17	73.5120	126.79670

[Table/Fig-7]: Descriptive statistics of distance between centric points in both the techniques.

Variables	N	Minimum	Maximum	Mean	Standard deviation
Centric distribution (µ)	19	14.05	539.17	174.1075	144.26669

[Table/Fig-8]: Descriptive statistics in cases where centric points did not coincide.

Variables	N	Gender (n)	Mean (µ)	Standard deviation (µ)	Mean difference (µ)	p-value
Centric distribution in all cases	45	Male (13)	85.17	149.17	16.40	0.699
		Female (32)	68.77	118.85		
Centric distribution in positive cases	19	Male (6)	184.55	177.2	15.26	0.837
		Female (13)	169.28	134.37		

[Table/Fig-9]: Comparison of centric distribution among gender.
Independent t-test; p-value <0.05 was considered as statistically significant

Paired t-test was used to analyse the work load on the masseter and temporalis muscle of right and left side in both the techniques [Table/Fig-10]. The workload on both side was statistically insignificant. The p-value for right masseter in technique 1 and 2 was 0.088, for left masseter in technique 1 and 2 was 0.3, right temporalis in technique 1 and 2 was 0.463, left temporalis in technique 1 and 2 was 0.429. This showed that the muscles worked similarly in both the techniques at CR. When the two techniques were compared, technique 1 showed right temporalis having mean amplitude of 51.468. The least load was recorded in left masseter in both the techniques. The left masseter in technique 1 recorded the least workload (mean amplitude of 36.244).

Groups	Mean	SD	Mean difference (SD)	p-value
EMG Masseter R1	37.2956	22.9	-2.057 (7.9)	0.088
EMG Masseter R2	39.3533	26.2		
EMG Masseter L1	36.244	24.04	-1.01 (6.4)	0.3
EMG Masseter L2	37.255	26.11		
EMG Temporalis R1	51.468	25.63	1.055 (9.56)	0.463
EMG Temporalis R2	50.41	18.79		
EMG Temporalis L1	49.828	24.25	-1.08 (9.07)	0.429
EMG Temporalis L2	50.9	26.64		

[Table/Fig-10]: Comparison of Electromyography (EMG) between two sides using paired t-test.
R: Right; L: Left; 1: Technique 1; 2: Technique 2
p-value <0.05 was considered as statistically significant

The AP and SI difference in the position of the condyle was analysed using paired t-test. [Table/Fig-11] shows that statistically there was neither a difference between the right and left AP nor in right and left SI positions. The p-value for AP measurement in the right side in technique 1 and 2 was 0.448, AP measurement in the left side in technique 1 and 2 was 0.178, SI measurement in the right side in technique 1 and 2 was 0.803, SI measurement in the left side in technique 1 and 2 was 0.259. The highest distance found in AP on the left side was 6.287 mm in technique 2. The lowest was recorded in right SI positions in technique 2 (4.02 mm).

Groups	Mean	SD	Mean Difference (SD)	p-value
MRI Anteroposterior R1	6.015	1.69	0.049 (0.43)	0.448
MRI Anteroposterior R2	5.966	1.75		
MRI Anteroposterior L1	6.112	1.604	-0.17 (0.85)	0.178
MRI Anteroposterior L2	6.287	1.7		
MRI Superioinferior R1	4.036	0.74	0.016 (0.43)	0.803
MRI Superioinferior R2	4.02	0.83		
MRI Superioinferior L1	4.144	0.95	-0.146 (0.854)	0.259
MRI Superioinferior L2	4.29	1.42		

[Table/Fig-11]: Comparison of Magnetic Resonance Imaging (MRI) between two sides using paired t-test.
R: Right; L: Left; 1: Technique 1; 2: Technique 2
p-value <0.05 was considered as statistically significant

Further, multivariate test was applied to compare the difference of EMG [Table/Fig-12] and MRI [Table/Fig-13] status in all groups of both genders. Statistically significant results were found between gender and EMG results. Highly significant differences were found in temporalis right muscles in both (p-value=0.009 in technique 1, p-value=0.005 in technique 2) the techniques. However, there was no significant association between gender and MRI data when multivariate analysis was applied.

Groups	Male (13)	Female (32)	Mean difference	f-value	p-value
EMG Masseter R1	48.9 (37.42)	32.57 (11.3)	16.33	5.102	**0.029**
EMG Masseter R2	53.83 (43.12)	33.46 (11.59)	20.37	6.227	**0.016**
EMG Masseter L1	47.52 (36.66)	31.66 (14.99)	15.86	4.328	**0.043**
EMG Masseter L2	50.54 (41.7)	31.85 (13.7)	18.69	5.186	**0.028**
EMG Temporalis R1	66.71 (41.83)	45.27 (10.86)	21.44	7.41	**0.009**
EMG Temporalis R2	62.44 (28.0)	45.52 (10.57)	16.92	8.82	**0.005**
EMG Temporalis L1	58.6 (38.02)	46.26 (15.16)	12.34	2.474	0.123
EMG Temporalis L2	62.71 (41.6)	46.11 (15.99)	16.6	3.82	0.057

[Table/Fig-12]: Multivariate Analysis- test was done to compare the differences of Electromyography (EMG).
R: Right; L: Left; 1: Technique 1; 2: Technique 2
p-value <0.05 was considered as statistically significant

DISCUSSION

In the present study, there was no significant difference between the Dawson's bimanual technique and the wax ball orientation technique when compared clinically, electromyographically and radiographically. The Dawson's bimanual technique is a time tested method whereas the wax ball orientation technique is a newer method of guiding the mandible to CR. Both the techniques and the advantages, disadvantages have been clearly explained in the authors previous comparative study [4]. Various studies in literature have compared the Dawson's bimanual method with other clinical techniques which have showed conflicting results [Table/Fig-14] [1,2,9,11,12,16]. Many authors have also emphasised on the importance of tongue in registering CR [27-29].

Groups	Male (13)	Female (32)	Mean difference	f-value	p-value
MRI Anteroposterior R1	6.34 (1.62)	5.88 (1.73)	0.465	0.687	0.412
MRI Anteroposterior R2	6.21 (1.72)	5.86 (1.78)	0.35	0.363	0.55
MRI Anteroposterior L1	6.38 (1.66)	6.0 (1.59)	0.382	0.520	0.475
MRI Anteroposterior L2	6.51 (1.57)	6.2 (1.76)	0.32	0.32	0.575
MRI Superioinferior R1	4.1 (0.71)	4.01 (0.76)	0.09	0.133	0.717
MRI Superioinferior R2	4.1 (0.69)	3.98 (0.89)	0.113	0.167	0.685
MRI Superioinferior L1	4.2 (0.79)	4.12 (1.02)	0.078	0.06	0.806
MRI Superioinferior L2	4.21 (1.04)	4.32 (1.56)	-0.106	0.05	0.825

[Table/Fig-13]: Multivariate Analysis- test was done to compare the differences Magnetic Resonance Imaging (MRI) status in all groups of both genders.
R: Right; L: Left; 1: Technique 1; 2: Technique 2;
p-value <0.05 was considered as statistically significant

The EMG integrator-average demonstrates sensitivity to changes in the muscle activity, further; the EMG records are capable of detecting differences in average/μV amplitude levels [25]. Buxbaum J et al., indicated that the muscle activity increases in CR position compared to maximum intercuspation. The results of their study demonstrated a significant increase in xVin CR. Average/μV amplitude levels of the masseter and anterior temporalis muscles at CR was higher than MI. When masseter and temporalis was evaluated individually average/μV amplitude levels were higher for temporalis which is in accordance with the results of our study [26]. Jeminez ID checked whether the AP changes in various mandibular positions affected the masticatory muscle activity, and showed that the CR position required more muscle activity (temporal and masseter) compared to the other position during mastication, deglutition and respiration [30]. Woelfel J et al., and Owens SE et al., separately studied the importance of lateral pterygoid in CR and found that the lateral pterygoid muscle is inactive during the pure hinge movement of the mandible [31,32].

The EMG reading is result of inhibition of motor neurons in the temporal and masseter muscles. The effect of secondary endings in muscle spindle and Golgi organ is most likely responsible for electrical activity in temporalis muscle and masseter muscle activity. However, the major neural activity takes place in the trigeminal motor neurons [33]. Earlier studies have concluded that masseter contributes to isometric force made while cleaning whereas temporalis is a postural muscle which controls mandible during excursive movements and also movements like swallowing and chewing [34-36].

Carwell ML and McFall WT studied the condylar position using clinical and radiographic (lateral cranial oblique positions) technique. The clinical technique compared was Dawson's bimanual method, Chin point guidance, anterior guidance, jig. The authors concluded that, centric contact points on the teeth were similar with all the bimanual manipulation on radiographs [37]. Velos S et al., compared the condylar position in CBCT after the static and dynamic registration of CR and concluded that dynamic registration was reliable and an accurate method, as there were higher condylar symmetry and the centred position in articular fossa [38]. Kandasamy S et al., assessed condylar position by MRI after common bite registration; centric occlusion, retruded CR and Roth-power CR. The study failed to support the claim that certain bite registrations accurately position condyles in specific position in glenoid fossa [23].

Author's name and year of publication	Place of study	Number of subjects	Techniques for CR compared	Conclusion
Alvarez MC et al., (2009) [1]	Department of dental materials and Prosthodontics, Dental school of Rebeiro Preto, University of Sao Paulo, Brazil	10 patients aged 25 to 39 years were recruited for the study.	1. Compared swallowing technique with chin point guidance method. 2. Compared Swallowing technique with Bimanual manipulation	1. There was no statistically significant difference among the methods for recording lateral displacement. 2. 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.
Mckee JR (2005) [2]	Downers Groove, Illinois, United States of America	11 dentists without any TMJ disorders were recruited for the study. CR records were made for each dentist by other 3 participant dentists. Thus, 3 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 4 different interocclusal wax records (3 in reclined position and 1 in upright position)	1. Compared swallowing technique with chin point guidance method. 2. Compared Swallowing technique with Bimanual manipulation	1. There was no statistically significant difference among the methods for recording lateral displacement. 2. Swallowing method differed significantly from other methods for AP displacement; however there was no difference between chin point guidance and bimanual manipulation in the AP direction.
Keshvad A and Winstanley RB, (2003) [9]	Department of adult dental care, School of clinical dentistry, University of Scheffield, Scheffield, United Kingdom	Total number of patients: 14 (average age 26.61±4.20 years and having complete dentition).	1. Bimanual mandibular manipulation with a jig, 2. Chin point guidance with jig 3. Active (Unguided) Gothic arch tracing b asking the patient to carry out excursive movements. Casts were mounted on Denar D4A by means of facebow and MI silicone registration record. Mandibular positional indicator was constructed for the positional analysis of condyles in three spatial axes.	1. 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. 2. Chin point guidance was found to be better than the gothic arch tracing. Further, the centric position obtained with gothic arch tracing was anterior to that obtained with bimanual manipulation (0.2 mm to 1.2 mm).
C˘elar A et al., (2013) [11]	Orthodontic Division, Bernhard Gottlieb Dental Clinic, Medical University of Vienna, Vienna, Austria	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 6 measuring gauges that displayed XYZ spatial coordinates of the left and right condylar positions.	In the sagittal plane: a. On the left: both BM (bimanual position) and NM (Non manipulation) was located posterior and inferior to Inter Cuspal Position (ICP). b. 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 Anteroposteriorly on the right side.
Kazanji M et al., (2014) [12]	School of Dentistry, Faculty of Medical sciences, Duhok University, Iraq	30 edentulous patients aged between 45-65 years.	Group A: Swallowing method Group B: Chin point guidance was used. Group 3: Bimanual manipulation was used to guide the mandible into CR.	There was no significant difference in the mean of the three methods used to guide the mandible to CR.
Millet C et al., (2003) [16]	Department of Prosthodontics, Dental School, Claude Bernard Lyon I University, Lyon, France.	15 healthy subjects (Six men and nine women) between 45 and 81 years (mean age of 63± years.	1. Compared bimanual manipulation and swallowing method to record the CR 2. Compared swallowing and traditional technique (Niswonger's method) to record vertical dimension and CR	In the sagittal plane, the mandibular position during swallowing was considerably anterior compared to bimanual manipulation with the mean difference of 2.0±0.7. 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.
Present study, 2022	School of Dental Sciences, KIMSDU, Karad, Maharashtra, India	45 study subjects considered for the study, 32 were females and 13 were males with the mean age of 21.	Technique 1: Dawson's bimanual technique Technique 2: Wax ball orientation technique Were used to guide the mandible into CR and the results were analysed in a. Clinical Phase b. Electromyographical phase c. Radiological phase	There was no significant difference among the two techniques used to guide the mandible to CR.

[Table/Fig-14]: Various studies comparing clinical techniques for Centric Relation (CR) [1,2,9,11,12,16].

Limitation(s)

The sample size taken was small. Use of scanning electron microscope would have been preferable as the stereo microscope had only 45x magnification.

CONCLUSION(S)

The authors conducting research on this new guiding technique have presented it in a new light with a concrete scientific base and undiscountable evidence. The wax ball technique has similar accuracy as the Dawson's Bimanual technique and can be used clinically as a new guiding technique for mandible to CR position. The study has a scope to be performed on a large sample to give a more conclusive statement. Use of Scanning electron microscope can be added in the methods performed to obtain more precise measurements.

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REFERENCES

[1] Alvarez MC, Turbino ML, Barros CD, Pagnano VO, Bezzon OL. Comparative study of intermaxillary relationships of manual and swallowing methods. Braz Dent J. 2009;20(1):78-83.
[2] McKee JR. Comparing condylar positions achieved through bimanual manipulation to condylar positions achieved through masticatory muscle contraction against an anterior deprogrammer: A pilot study. J Prosthet Dent. 2005;94(4):389-93.
[3] Academy of denture prosthetics. The Glossary of Prosthodontic Terms: 9th ed. J. Prosthet. Dent. 2017;117(5S):e20.
[4] Sushma R, Roy MS, Sanyal PK, Joshi A, Vande A, Kore AR. A clinical comparative study to assess the efficacy of a new centric registration technique with a conventional technique. J Indian Prosthodont Soc. 2019;19(4):290.
[5] Keshvad A, Winstanley RB. An appraisal of the literature on centric relation. Part I. J Oral Rehabil. 2000;27(10):823-33.
[6] Keshvad A, Winstanley RB. An appraisal of the literature on centric relation. Part II. J Oral Rehabil. 2000;27(12):1013-23.
[7] Keshvad A, Winstanley RB. An appraisal of the literature on centric relation. Part III. J Oral Rehabil. 2001;28(1):55-63.
[8] Thakur M, Jain V, Parkash H, Kumar P. A comparative evaluation of static and functional methods for recording centric relation and condylar guidance: A clinical study. The Journal of Indian Prosthodontic Society. 2012;12(3):175-81.
[9] Keshvad A, Winstanley RB. Comparison of the replicability of routinely used centric relation registration techniques. Journal of Prosthodontics. 2003;12(2):90-101.
[10] McKee JR. Comparing condylar position repeatability for standardised versus nonstandardised methods of achieving centric relation. The Journal of Prosthetic Dentistry. 1997;77(3):280-84.
[11] Čelar A, Freudenthaler J, Crismani A, Graf A. Guided and unguided mandibular reference positions in asymptomatic individuals. Orthodontics & Craniofacial Research. 2013;16(1):28-35.
[12] Kazanji M, Habib S, Qadir A. Reproducibility of centric jaw relation record for edentulous patients, Duhok Med J. 2014;8(1):61-67.
[13] Bansal S, Palaskar J. Critical evaluation of methods to record centric jaw relation. J Indian Prosthodon Soc. 2008;8(4):185-91.
[14] Bansal S, Palaskar J. Critical evaluation of methods to record centric jaw relation. The Journal of Indian Prosthodontic Society. 2009;9(3):120-26.
[15] Kurth LE. Methods of obtaining vertical dimension and centric relation: A practical evaluation of various methods. J Am Dent Assoc. 1959;59(4):669-73.
[16] Millet C, Jeannin C, Vincent B, Malquarti G. Report on the determination of occlusal vertical dimension and centric relation using swallowing in edentulous patients. J Oral Rehabil. 2003;30(11):1118-22.
[17] Dawson PE. Relation centric. Its effect on occluso-muscle harmony. Dent Clin North Am. 1979;23(2):169-80.
[18] Dawson PE. Functional Occlusion: From TMJ to smile design. St. Louis: CV Mosby; 2007.
[19] Zarb GA, Bolender CL, Eckert SE, Jacob R, Fenton A, Mericske-Stern R. Prosthodontic treatment for edentulous patients. Complete dentures and implant-supported prostheses. 12th. ed. St. Louis: Mosby. 2004.
[20] Sushma R, Kore AR, Sanyal PK, Joshi A, Hathiwala S, Tayde PN. Techniques to guide mandible to centric relation-A systematic review. J Clin Diagn Res. 2021;15(7):ZE01-07.
[21] Hughes GA, Regli CP. What is centric relation? Journal of Prosthetic Dentistry. 1961;11(1):16-22.
[22] White SC, Pharaoh MJ. Oral radiology: Principles and Interpretation. 5th Ed. St. Louis: CV Mosby; 2004.
[23] Kandasamy S, Boeddinghaus R, Kruger E. Condylar position assessed by magnetic resonance imaging after various bite position registrations. Am J Orthod Dentofacial Orthop. 2013;144(4):512-17.
[24] Orthlieb JD, Hernandez G, Darmouni L, Ré JP, Girardeau A, Slavicek G. Myostabilized centric relation. International Journal of Stomatology & Occlusion Medicine. 2011;4(3):87-94.
[25] Buxbaum JD, Parente FJ, Ramsey WO, Staling LM. A comparison of centric relation with maximum intercuspation based on quantitative electromyography. J Oral Rehabil. 1982;9(1):45-51.
[26] Buxbaum J, Parente F, Pridgeon CT, Pidgeon GM, Ramsey WO, Staling LM. The intrasubject reliability of an EMG intergrator-averager for bilateral masseter activity. J Baltimore Coll Dent Surg. 1977;32:88-96.
[27] Hickey J, Zarb G, Bolender C. Boucher's Prosthodontic treatment for edentulous patients. 9th ed. St. Louis: CV Mosby; 1985.
[28] Fenn HRB, Liddelow KP, Grimson AP. Clinical dental prosthetics. 2nd ed. London: Staples Printers Limited; 1961.
[29] Bissasu M. Use of the tongue for recording centric relation for edentulous patients. J Prosthet Dent. 1999;82:369-70.
[30] Jimenez ID. Electromyography of masticatory muscles in three jaw registration positions. Am J Orthod Dentofac Orthop. 1989;95(4):282-88.
[31] Woelfel, J, Hickey J, Rinera L. Electromyographic evidence supporting the mandibular hinge axis theory. J Prosthet Dent. 1957;7(3):361-67.
[32] Owens SE, Lehr RP, Biggs NL. The functional significance of centric relation as demonstrated by electromyography of the lateral pterygoid muscles. J Prosthet Dent. 1975;33(1):05-09.
[33] Nanda A, Jain V, Srivastava A. An electromyographic study to assess the minimal time duration for using the splint to raise the vertical dimension in patients with generalized attrition of teeth. Indian. J Dent Res. 2011;22(2):303-08.
[34] Kerstein RB. Combining technologies: A computerized occlusal analysis system synchronized with a computerized electromyography system. Cranio. 2004;22(2):96-109.
[35] Christensen LV, Kundinger KK. Activity index and isometric contraction velocity of human jaw muscles. J Oral Rehabil. 199;18(6):555-61.
[36] Visser A, McCarroll RS, Naeije M. Masticatory muscle activity in different jaw relations during submaximal clenching efforts. J Dent Res. 1992;71(2):372-79.
[37] Carwell ML, McFall WT. Centric relation determinations: Clinical and radiographic comparisons. J Periodontol. 1981;52(7):347-53.
[38] Veloso L, Dias R, Messias A, Fonseca J, Nicolau P. Evaluation of condylar position by CBCT after static and dynamic registration in edentulous patients. Rev Estomatol Med Dent Cir Maxillofac. 2015;56(1):09-17.

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