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COMPARATIVE EVALUATION OF HORIZONTAL CONDYLAR GUIDANCE ANGLE OBTAINED BY USING TWO DIFFERENT INTEROCCLUSAL RECORDS. A CLINICAL STUDY.

Dental Science

Dr. Bhushan S. Gaikwad* MDS Prosthodontics, PGDCR, PGDMLS Lecturer/Asst Prof Department of Prosthodontics and Crown & Bridge Sinhgad Dental College and Hospital, Pune. *Corresponding Author

Dr. Jayant N. Palaskar MDS Prosthodontics Professor and Head Department of Prosthodontics and Crown & Bridge Sinhgad Dental College and Hospital, Pune.

Dr. Apeksha B. Gaikwad BDS Head Clinician Dr. Bhushan's Dental Clinic, Bibwewadi, Pune.

ABSTRACT

The study compared and evaluated horizontal condylar guidance (HCG) angle obtained by programming a semi-adjustable articulator using maximum intercuspation and protrusive interocclusal records, mounting the maxillary and mandibular casts in centric relation. Maxillary and mandibular casts were obtained, orientation and centric relations records were made and transferred on to a semi-adjustable articulator. Interocclusal records were obtained in maximum intercuspation and protruded positions followed by programing of the articulator. The mean HCG observed using maximum intercuspation interocclusal record on left and right side were 36.57º (SD ±3.53º) and 36.70º (SD ±3.68º). Similarly, the mean HCG obtained using protrusive interocclusal recorded on left and right side were 41.67º (SD ±3.64º) and 41.77º (SD ±3.35º). From statistical analysis it was found that there was a significant difference between the two groups ($p<0.01$) with a mean difference of 5.1º and 5.06 º on the left and right HCG. There was a positive correlation between the left and right HCG obtained by the two interocclusal records. The HCG values obtained by protrusive interocclusal record are more reliable when compared to maximum intercuspation records. However, further imaging studies are needed to correlate the anatomic findings with the present study.

KEYWORDS

Semi-adjustable articulator, occlusal rehabilitation, condylar guidance, interocclusal records, centric relation.

INTRODUCTION

Complex prosthodontic treatment, fixed or removable, involves the skill of a clinician to provide a prosthesis that is in harmony with the stomatognathic system. This is possible only with the help of a mechanical instrument that can be used in the absence of patient. The instrument should allow the clinician to diagnose and deduce a treatment plan, and also facilitate dental technician to fabricate the prosthesis.

In dentistry, semi-adjustable articulators are used to simulate certain interocclusal positions and mandibular movements as seen in the patient. The accuracy with which these movements are replicated depends on the sophistication and adjustability of the articulator (Donegan, & Christensen, 1991).

As the condyle moves out of centric relation (CR) it descends along the articular eminence of the mandibular fossa. The angle at which the condyle moves away from the horizontal reference plane is referred to as condylar guidance i.e. downward and forward displacement of the condyle and is peculiar to each patient (Okeson, 2004, p. 540., Sharry, 1983, p.254). The condylar element on a semi-adjustable articulator glide in slots and can be inclined to provide a rectilinear simulation of the curvilinear condylar path independent of teeth contact (Donegan, & Christensen, 1991). In order to program the horizontal condylar guidance angle (HCG) in a semi-adjustable articulator, a protrusive interocclusal record (PR) is required. The interocclusal record is positioned between the mounted casts followed by programming the HCG; this is a widely practiced and accepted method (Posselt, 1968., Mohl, et. al. 1988., Posselt, 1968., Rosensteil, Land, & Fujimoto, J. 2006).

If HCG is not recorded accurately, it may lead to occlusal interferences during functional movements resulting in increased chair side time for adjustment of prosthesis(Pelletier, & Campbell, 1991).

Literature indicates the use of lateral cephalograms, pantomographs, and tomographs for recording HCG. Studies have shown that radiographs can record the HCG more accurately (dos Santos Júnior, Nelson, & Nummikoski, 1996., Christensen, & Slabbert, 1978., Gilboa, Cardash, Kaffe, & Gross, 2008). The inconvenience and radiation exposure are main concerns for application of radiographs thus it is the main deterrents for widespread usage to estimate HCG (Shreshta, Jain, Bhalla, & Pruthi, 2012).

Occlusion in CR is called as centric occlusion (CO) an in natural dentition the maximum intercuspation (MI) of teeth is not found to be in CR i.e. CO does not coincide with MI. During CO first contact of maxillary and mandibular teeth is observed which will then guide the mandible to attain MI position displacing the condyles. This is called as centric slide or simply slide and is defined as a movement of the mandible from CO to MI (Hodge, Mahan, 1967).

Due to centric slide the condyles are displaced downward and forward position which means that the condyles are along the slope of the articular eminence. During protrusion the condyles are along the slope of the articular eminence. As the positions, MI and protrusion, render the condyles along the slope of the articular eminence, the MI interocclusal record could be equally effective in programming the HCG angle in the semi-adjustable articulator.

Thus, the present study was conducted to compare the effectiveness of the MI and PR interocclusal record to program the HCG angle on a semi-adjustable articulator with CR as the starting point. In this study it was hypothesized that there is a difference between the HCG angle obtained by using the MI and PR interocclusal record on a semi-adjustable articulator.

MATERIALS AND METHOD

This observational comparative study was conducted and reported as per strengthening the reporting of observational studies in epidemiology (STROBE 2007) guidelines. In the present study, 30 participants within the age group of 19 to 23years were selected. Selection was done on the basis of inclusion and exclusion criteria.

Inclusion criteria

- Angles class I molar relation on left and right side.
- Minimum of 28 teeth present.

Exclusion criteria

- Malocclusion.
- Missing teeth.
- Undergone fixed or removable prosthetic treatment.
- Undergone any form of orthodontic treatment.
- Temporomandibular disease signs and symptoms.
- History of maxillofacial trauma.

Each participant was provided with participant information sheet and a consent form. Only after the participant was fully aware of the

procedure and consent form duly signed, they were considered as study subjects.

Preparation of Maxillary and Mandibular Casts

Maxillary and mandibular Alginate (Zelgan 2002, Dentsply. Germany.) impressions were made and poured in type III dental stone (Ultrastone, Kalabhai, India) and type II dental plaster (Kaldent, Kalabhai, India) was used to form the base. The maxillary cast was indexed in order to facilitate split cast mounting technique (Lauritzen, Wolford, 1964) (Figure 1).

Figure 1 Indexed maxillary cast with split cast mounting technique

Orientation Jaw Relation and mounting maxillary cast:

Orientation jaw relation was recorded using face-bow (The Hanau™ Spring-Bow, Whipmix. USA) (Figure 2) and was transferred on to the semi-adjustable articulator (Hanau™ Wide-Vue Arcon Articulator, Whipmix. USA) using a mounting jig (Hanau™ Spring-Bow, Whipmix. USA).

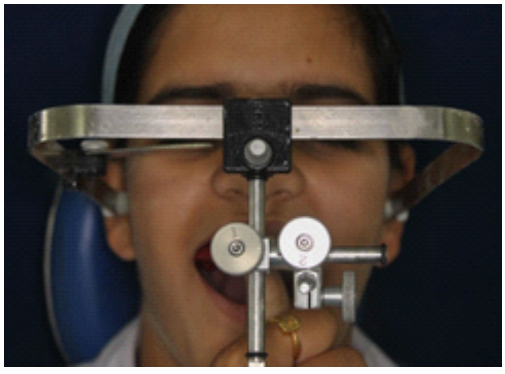

Figure 2 Recording orientation relation using a face bow

Making Interocclusal Records

Three different interocclusal records were made:

1 CR interocclusal record
2. MI interocclusal record.
3. PR interocclusal record.

1. Registration of CR interocclusal record: Anterior index combined with Dawson's technique for recording CR was followed (Dawson, 2007). On confirming the CR, bite registration paste (Orangebite, Medicept, UK) was dispensed between posterior teeth and the record was transferred on to the articulator (Figure 3).

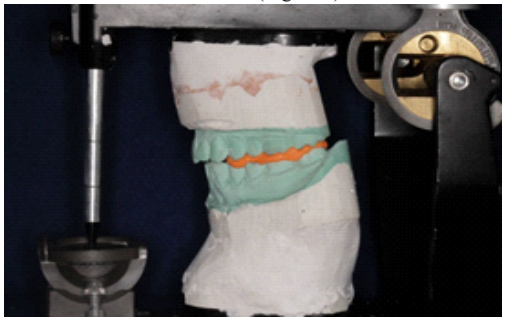

Figure 3 Mounting in centric relation on semi-adjustable articulator.

2. Registration of MI Interocclusal Record: The MI interocclusal record was made using tempered impression compound. The material was placed over the mandibular posterior teeth and the subject was asked to close in MI. After the material hardened, it was carefully retrieved and stored under water at room temperature.

3. Registration of PR interocclusal record: The subject was trained to close in an edge-to-edge position. Once the subject was familiar with the process, tempered impression compound was placed on the mandibular posterior teeth and the subject was assisted to close in an edge-to-edge position. The interocclusal record material was retrieved and stored.

The interocclusal records were trimmed to eliminate soft tissue contact on the cast. Contact with the occlusal surface was permitted ensuring complete seating of interocclusal records between the casts. The mandibular cast was oriented over the maxillary cast with CR interocclusal record and mounting was completed using type II dental plaster.

Verification of CR

The CR interocclusal record was removed, incisal pin on the semi-adjustable articulator was raised and the articulator was closed over a 40µm thick articulating paper (Arti-Check, Bausch, Germany). The first tooth contact marking on the maxillary and mandibular cast marked by the articulating paper was observed and verified intraorally in each subject. In case a discrepancy was observed, the CR interocclusal record was re-recorded and remounting of mandibular cast was done.

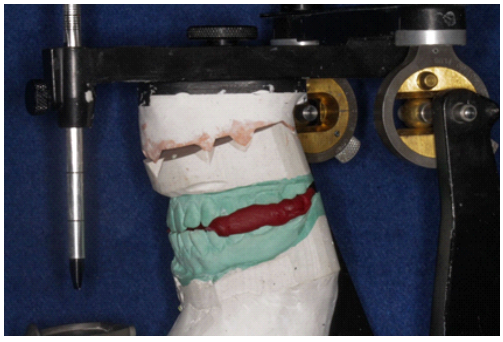

Figure 4 Protrusive interocclusal record placed without programing of the articulator

HCG Values obtained by MI and PR Interocclusal Record

Maxillary cast was separated from the split cast mounting. The MI interocclusal record was positioned on the mandibular cast and maxillary cast was carefully placed over it. The incisal pin was raised, centric lock and HCG screws were loosened on the articulator. The upper member of the articulator was closed over the maxillary cast. The HCG screw was moved until there was no visible space between the base of the indexed maxillary cast and the split cast. After ensuring the seating of split cast in the index grooves, the HCG was recorded on left and right side respectively. Similarly the PR was placed; programming of the articulator was done followed by recording the left and right HCG (Figure 4 and Figure 5).

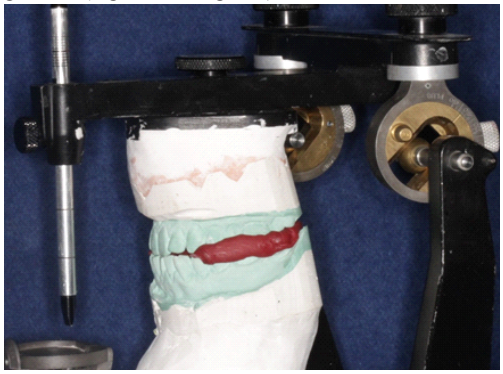

Figure 5 Protrusive interocclusal record in place after programing of the articulator

Statistical Analysis

Data was collected and entered in Microsoft Excel sheet for further analysis. Unpaired't'-test was used to check the level of significance and Pearson's correlation test was applied to check the correlation of left and right HCG. All statistical tests were done using SPSS 21.0 version. Statistical significance was set at $p<0.01$

RESULTS

In the present study a sample size of 30 individuals was considered and the HCG angle was measured on left and right side using MI and PR interocclusal records. Using the MI interocclusal record it was observed that the mean HCG angle was 36.57º (SD ±3.53º) on the left side and 36.70º (SD ±3.68º) on the right side. When PR interocclusal record was used the mean HCG angle was 41.67º (SD ±3.64º) on the left side and 41.77º (SD ±3.35º) on the right side. The mean difference of the left HCG angle obtained by MI and PR interocclusal record was 5.1º indicating a significant difference (p<0.01). Whereas the mean difference on the right side HCG angle between MI and PR was 5.06º indicating significant difference (p<0.01).(Table 1)

Table 1: Mean and standard deviation (SD) of left and right HCG angle obtained by MI and PR and also Mean difference (MD) and *p* value

Side	Interocclusal Record	Mean	SD	MD	p
Left	MI	36.57º	±3.53º	5.10º	<0.01*
	PR	41.67º	±3.642º		
Right	MI	36.7º	±3.687º	5.06º	<0.01*
	PR	41.77º	±3.350º		

* statistically significant

Pearson's correlation test was applied to test the correlation between the left and right HCG obtained from MI and PR interocclusal record. The test for correlation showed positive correlation between the left and right HCG (r= +0.861) obtained by MI interocclusal record and also for HCG angle obtained by PR interocclusal record (r= +0.935) and these correlations was statistically significant (p<0.01) (Table 2).

Table 2: Coefficient of correlation (*r*) between left and right HCG angles obtained by MI) and PR.

	r	p
Left MI/ Right MI	+0.861	p<0.01*
Left PR/ Right PR	+0.935	

* statistically significant

DISCUSSION

The present definition of CR describes the anatomic position of the condyle in relation to the disk and glenoid fossa (Palaskar, Murali, Bansal, 2013). The only way to evaluate the position is by surgically opening the temporomandibular joint (TMJ) and looking at it while it is in a specific spatial position which is totally impractical, although it can be applied to cadavers (Keshvad, Winspanley, 2000). Radiography was recommended as a solution to this problem but this method can only assess two dimensionally the position of one joint at a time (Keshvad, Winspanley, 2000., Keshvad, Winspanley, 2000., Keshvad, Winspanley, 2001). Cone beam computed tomography has been used to check the condylar position in a three-dimensional perspective (Ferreira, et.al. 2009). Dawson (1973) has explained the bimanual manipulation technique which promises to place the condyles in an anterior superior position as defined. This position is observed to be stable and most comfortable. As CR is a repeatable position it can be called as the starting point of all mandibular movements (Dawson, 1973).

To perform full mouth rehabilitation or complex prosthetic restorations, orientation relation is recorded and transferred to a semi-adjustable articulator. Other records include CR and/or MI and PR are made and are essential to calibrate the semi-adjustable articulator. The CR interocclusal record is used to articulate the mandibular cast with maxillary cast in CR. As the CR is the starting point of all movements, the relation should be recorded. MI interocclusal record provides information on the habitual relation of the two jaws and also the occlusal contacts as governed by the teeth. In situations when small prosthetic restorations are to be made, the casts are articulated on the articulator in MI. The reason for this is because there are other teeth to guide the jaw in MI and thus the position can be reproduced. In instances where full mouth rehabilitation is indicated the MI position becomes more of a subjective affair after all the teeth are prepared, in such situations CR is a theoretically acceptable interocclusal record. The MI position is a tooth dependent phenomenon and was observed to cause displacement of the condyles in various planes. As the CR position is a more stable and comfortable position, the MI interocclusal would have less value during complex prosthetic restorative procedure. MI position is not a border movement like the CR, thus in complex situations the reliability of the MI interocclusal records becomes questionable.

Several extra oral and intra oral clinical methods are used to record the HCG angle (Cardash, Kaffe, & Gross, 2008., Hickey, Zarb, Bolender, 1985). During routine procedures it cannot be justified to expose the patient to radiation for observing HCG angle and also the process is inconvenient (Shreshta, Jain, Bhalla, & Pruthi, 2012). Due to these reasons it may be more practical to program the HCG angle in the semi-adjustable articulator by using interocclusal record. A PR interocclusal record can register the influence of the condylar paths over the movements of the mandible and also to approximate the anatomic limits of the TMJ. It allows the HCG angle of the articulator to be set to an approximation of the paths of the condylar movements in patient (Winkler, 2000). This allows the maximum benefit from using an articulator and facilitates the fabrication of accurate restorations with a minimal time required for adjustments (Schillingburg, Hobo, Whitsett, 1981). Studies conducted by various authors found variations in HCG angles ranging from 5º-55º (Zamacona, Otaduy, Aranda,1992., dos Santos Jr, Nelson, Nowlin, 2003., Lundeen, Wirth, 1973., Woelfel, Winter, Igarashi, 1976., Hobo, Mochizuki, 1982). In the present study the mean HCG angle obtained by PR interocclusal record was 41.67º (SD ±3.64º) on left side and 41.77º (SD ±3.35º) on the right side which is in accordance to previous studies. The left and right side showed significant level of correlation (r= +0.935) which stands correct due to anatomical association. The minimum HCG angle observed on left and right side were 35º and 35º and, maximum values were 48º and 47º respectively. The HCG angle values obtained by PR interocclusal records were comparable to the previous studies done using interocclusal records. The potential reasons for variations in the HCG angle values may be due to the type of population, interocclusal recording material, instrument used for programming and the amount of protrusion of the mandible (Gross, et.al. 1998). In the present study impression compound was used to make interocclusal records due to its physical property of being rigid. Elastomeric materials are also available as bite registration pastes. As the elastomeric material, however rigid, possesses the ability to compress and flex due to its inherent nature, may result in discrepancy in HCG angle (Rahul, et.al. 2014).

MI or habitual position is known to have teeth in tight intercuspation and rarely coincides with CO. Historically CR has been considered mainly as a position posterior to MI (Remien, Ash Jr, 1974). CR and other occlusal relationships are conceived as positions which can be studied in three dimensions. (Paul, Silverman, Gratinker, 1973). Clinically, the difference between the two occlusal positions, CR and MI, can easily be determined by closing the mandible in its CR position by manual guidance until the first tooth contact is established. If the subject is then requested to squeeze the teeth together it will permit the mandible to slide towards MI. This centric slide is easy to observe clinically and has been studied to evaluate the spatial position of the condyles in MI (Ferreira, et.al. 2009., Abraham, Veeravalli, 2012). Studies observed the position of condyle from CR to MI, some concluded that there was no statistically significant difference between the two positions[9] while others said that there was statistically significant difference (Hodge, Mahan, 1967., Weffort, de Fantini, 2010). The variations in results of previous studies may be due to the technique used for evaluating the discrepancy in the two positions and also the understanding of CR definition.

Čimić et al (2016). conducted a study to test the direction of possible slide from CR to MI in subjects having Angles class I, Angles class II subdivision 1 and 2, and Angles class III using electronic ultrasound motion capture device (ArcusDigma II, Kavo, Biberach, Germany) and found that the condyle was displaced in an anteroinferior direction (Čimić, et.al. 2016). Previous studies also observed that the condyle exhibited inferior movement during centric slide (Weffort, de Fantini, 2010., Wood, Elliott, 1994., Klar, et.al. 2003). None of the studies in the literature observed the HCG angle during MI position making the current study unique.

Due to the slide observed from CO in to MI position it was hypothesized that the MI interocclusal record could yield equivalent HCG angle value as the PR interocclusal record. To test the null hypothesis, the left HCG angle obtained by MI interocclusal record was compared to the left HCG angle obtained by PR and the same was carried out for the value on right side as well. According to the statistical analysis, the values of HCG angle obtained by PR on the left and right side were statistically significant (p<0.01) when compared to the HCG angle obtained by MI interocclusal record. Thus the null hypothesis was rejected and the alternative hypothesis was accepted

stating that there is a statistically significant difference between the two methods. Although statistical analysis demonstrated that there was a significant difference, HCG by MI interocclusal records was less than HCG by PR interocclusal records. The possible reason for this difference is due to a further anteroinferior position of the condyles along the articular eminence during protrusion as interocclusal record was made at edge-to-edge position.

CONCLUSION

Within the limitations of the study it could be concluded that the PR interocclusal record still proves to be a gold standard when it comes to programming a semi-adjustable articulator. However further studies are necessary to compare the values obtained by anatomic structure and establish a foolproof method for accurate determination of HCG angle.

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