

A Comparative Evaluation of Static and Functional Methods for Recording Centric Relation and Condylar Guidance: A Clinical Study

Mridul Thakur · Veena Jain · Hari Parkash · Pravesh Kumar

Received: 3 April 2012 / Accepted: 5 July 2012 / Published online: 27 July 2012
© Indian Prosthodontic Society 2012

Abstract To evaluate and compare the centric relation and horizontal condylar guidance using interocclusal wax and extra oral Gothic arch methods and subjective evaluation of dentures thus fabricated. Centric relation and horizontal condylar guidance was recorded by using interocclusal wax and gothic arch tracing in 28 completely edentulous patients. These records were transferred to the articulator and difference in both values was recorded. After that patients were divided in two groups according to the centric relation and horizontal condylar guidance recording method used to achieve balanced occlusion. Response of the dentures was subjectively evaluated using “Woelfel subjective evaluation criteria”. Centric relation recorded by both the methods did coincide in 7.14 % of patients. Centric relation recorded by interocclusal wax was posterior to Gothic centric relation in 21.43 % of patients, and anterior to Gothic centric relation in 71.42 % patients. Gothic arch tracings gave higher mean guidance values on both the sides as compared to protrusive wax record in all the subjects, although the difference was statistically insignificant ($P > 0.05$). Subjective evaluation showed statistical insignificance for all the parameters in both groups. Gothic arch method records the centric relation at a more posterior position than the Static method, but it does not make any difference in clinical performance of

the complete denture. Horizontal condylar guidance angle was approximately similar by both the methods.

Keywords Centric relation · Horizontal condylar guidance · Complete denture

Introduction

Acquiring and transferring a dependable centric jaw relation record has long been a matter of great concern to prosthodontists. When the natural teeth are removed, many receptors, that initiate impulses resulting in positioning of mandible, are lost or destroyed. Therefore, an edentulous patient cannot control the mandibular movements or avoid deflective occlusal contacts in centric relation in the same manner as the dentate patient can. Deflective occlusal contacts in centric relation cause movement of denture bases and displacement of supporting tissues or direct the mandible away from this relation [1].

So importance and need of centric jaw relation position lies in the fact that it acts as a reference position for the development of occlusion in harmony with the entire stomatognathic system. Numerous methods of registering centric relation (CR) have been described in literature [1–5]. They can be classified as (1) static (2) Graphic (3) functional (4) Cephalometric. Functional methods are further divided into intra-oral and extra-oral methods. Among these, Inter-occlusal wax record (static) and the Gothic arch tracings (functional) are the most commonly used methods [1].

The inclination of the condylar path is a fundamental consideration in the prosthodontic treatment of completely edentulous patients. To develop occlusion in harmony with health and function of the stomatognathic system, we need to record condylar guidance values to adjust the articulator condylar guidance [6, 7].

M. Thakur · V. Jain · H. Parkash · P. Kumar
Department of Maxillofacial Prosthodontics, Centre for Dental Education and Research, All India Institute of Medical Sciences (AIIMS), New Delhi 110029, India

V. Jain (✉)
Department of Maxillofacial Prosthodontics, Centre for Dental Education and Research, All India Institute of Medical Sciences (AIIMS), Room No. 212, New Delhi 110029, India
e-mail: jainveena1@gmail.com

Extraoral or intraoral methods are used to record the horizontal condylar guidance (HCG). The extraoral methods generally are exemplified by Gysi and Mccollum methods. The intraoral methods are (1) Plaster and carbondum grinding; (2) Chew-in by teeth opposing wax; (3) Chew-in modified by central-bearing point; (4) Needles' styli cutting compound rim; (5) Needles' method modified by Messer man tracer; (6) Protrusive registration on softened compound; (7) Protrusive registration by plaster "check bites" (Stanberry); (8) Protrusive registration on softened wax [1, 8].

In day to day practice, intraoral wax protrusive record at try-in stage or extraoral tracings is preferred to record the horizontal condylar guidance [9–12]. However, in treatment of edentulous patients, graphic registering technique is recommended to verify the CR and to record the HCG [1].

Though both the interocclusal wax record and the Gothic arch methods have been used to record centric relation and condylar guidance yet there are certain drawbacks of each method. Main limitations of interocclusal wax method are inherent dimensional changes in the recording medium i.e. Wax, and a definite method of verification is not present [13]. Certain limitations of the Gothic arch method include effect of tissue resiliency; require proper ridge anatomy, stable denture bases, sufficient inter ridge distance, patient co-operation and co-ordination, good neuromuscular control, experienced operator and this method is time consuming [1, 13–15].

Therefore, this study was designed to evaluate and compare the variation in centric relation and HCG recorded by the interocclusal wax record and the Gothic arch methods and determination of denture quality and patients satisfaction after insertion of denture.

Materials and Methods

Ethical clearance was obtained from the institute ethical committee.

A total of twenty-eight edentulous patients within the age range of 45–65 years, irrespective of sex were selected according the exclusion and inclusion criteria. Patients with well healed and rounded ridges having firm, resilient mucosa, class I jaw relation, with no pain/discomfort in any part of the stomatognathic system or any neuromuscular disorder like Parkinsonism, epilepsy or any disorder of the TMJ and who had no previous experience of complete dentures (CD) were selected. These patients were randomly divided in two groups according to the method of recording centric relation (CR) and horizontal condylar guidance (HCG) used to achieve balanced occlusion (Table 1). Before starting the treatment, complete procedure was explained to the patient and his consent was taken.

Table 1 Grouping of patients for subjective

Group	Number of patients	Jaw relation record for fabrication of final prosthesis
Group I	14	Interocclusal wax centric relation and protrusive record at try-in stage
Group II	14	Gothic centric relation and protrusive record

Conventional procedure was used to fabricate the CD. Occlusal bite rims were fabricated to record the jaw relation records. One extra pair of bite rims were fabricated for half of the patients. Vertical jaw relations were established using a combination of mechanical and physiological [1] methods. Hanau spring bow (Teledyne/Water Pik) was used to mount the maxillary cast on the semiadjustable articulator (Hanau Wide Vue articulator, model 183). Mandibular cast was mounted against the maxillary cast with the help of wax Interocclusal CR record (Niswonger's method) [16].

Trial dentures were made, and at the try-in stage, jaw relations were verified and HCG was recorded at 6 mm of protrusion using interocclusal wax method [1, 17, 18]. HCG were adjusted using the wax protrusive record and teeth setting was modified for half of the cases (group-I) to achieve balanced occlusion.

At this stage other pair of occlusal rims was adjusted on the articulator to achieve the same vertical dimension, verified in oral cavity and kept aside.

Gothic arc tracing were recorded using the extraoral tracer attached to occlusal rims made in impression compound (DPI pinnacle) [1, 17]. The tracing was placed on the articulator to mark the centric relation point on the smoked tracer plate. Now a transparent sheet was attached to the tracing plate and difference between the centric relation records recorded by both the methods was measured. Centric and protrusive plaster records at 6 mm protrusive movement were made using quick-setting plaster between the mounting plates.

Mandibular cast was remounted using the Gothic centric relation and the protrusive plaster record was used to adjust the horizontal condylar guidance in all the patients. Occlusal rims (made with impression compound) were replaced with that made with wax (group II). Balanced occlusion was achieved in trial dentures.

Dentures were processed, remounted, finished and polished and delivered to the patients. These dentures were subjectively evaluated to determine the denture quality and patients satisfaction, using the Woelfel [19] criteria at different time intervals after denture insertion i.e. Immediately after insertion, after 48 h, after 1 week, 1 month and at 3 months.

Dentures were evaluated by an independent prosthodontist for all the parameters i.e. accuracy of centric relation,

retention of maxillary denture, retention of mandibular denture, stability of maxillary denture, stability of mandibular denture, condition of maxillary tissues and condition of mandibular tissues. Maxillary and mandibular basal seat tissues were examined for the sore sports with main emphasis on position of sore sports.

Patients also evaluated the dentures for retention, stability and ability to chew food with the complete dentures.

For subjective evaluation of denture quality rating legend given by Woelfel [19] was followed. The rating legend given by Woelfel for subjective evaluation is as follows:

I. Accuracy of centric relation

Score	Criteria
4	Centric relation and centric occlusion coincide
3	Slight variation (up to ½ mm) between centric and centric occlusion
2	Variation (2/3–1.5 mm) between CR and CO
1	A gross error between CR and CO which can be corrected only by resetting the teeth

II. Retention (denture to soft tissue relationship)

Score	Criteria
4	Extremely difficult to break border seal
3	Moderately difficult to break border seal
2	Slight resistance before border seal breaks
1	No border seal

III. Stability (denture to bone foundation relationship)

Score	Criteria
4	Little or no movement on application of strong direct or rotatory force.
3	Little or no movement on application of rotatory force but is dislodged when a strong force is applied to one side
2	Considerable movement on application of rotatory force and is dislodged by a moderate direct force
1	A slight force either rotatory or direct causes the denture to move and become dislodged or both

IV. Condition of tissues

Score	Criteria
4	Tissues are firm and appear healthy with no signs of abrasion or other injury caused by the dentures
3	The tissues are generally firm and appear healthy except for small isolated regions
2	Some movable tissue on the crest of ridge not previously present or irritated regions covering one-third of the denture bearing area
1	Large general regions of redness involving half or more of the denture bearing surface or a considerable amount of movable tissue not present before or both

All abnormal areas are to be scribed on the drawings and the following coding used

R	Redness (isolated)
I	Inflammation (general)
M	Hyperplastic tissues
U	Ulceration

Grading frequency of patient’s satisfaction with the dentures: Subjective evaluation

I. Does your upper denture stay in place?

Score	Criteria	Response
4	Completely fits and stays in place	Excellent
3	Slight instability on complex movements	Good
2	Slight instability on simple movements	Fair
1	Does not stay in place	Poor

II. Does your lower denture stay in place?

4	Stays in place properly	Excellent
3	Slight instability on complex movements	Good
2	Slight instability in simple movement	Fair
1	Does not stay in place	Poor

III. Can you chew your food well with your dentures?

4	Chew hard as well as soft food very well	Excellent
3	Chew soft food very well but some difficulty in chewing hard food	Good
2	Slight difficulty in chewing soft food	Fair
1	Unable to chew food	Poor

Statistical Analysis

Data was analyzed using SPSS software version 15.0 Non-parametric test was done for 2 samples, to find the value significance.

Results

CR recorded by both the methods did coincide in 7.14 % of patients. CR recorded by static method (interocclusal wax record) was posterior to that recorded by functional method (Gothic arch tracing) in 21.43 % of patients, while in 71.42 % patients CR recorded by static method

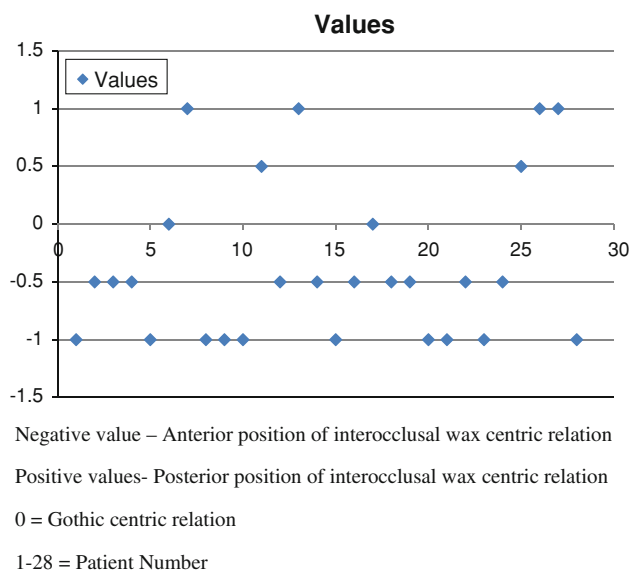


Fig. 1 Position of conventional centric relation relative to gothic centric relation ($N = 28$). Negative value—anterior position of interocclusal wax centric relation; positive values—posterior position of interocclusal wax centric relation; 0, gothic centric relation; 1–28, patient number

was anterior to that recorded by functional method with the variation in CR ranging between 0.5 and 1 mm (Fig. 1).

Gothic arch tracings gave higher mean HCG values on both the sides as compared to protrusive wax record at try-in stage in all the subjects, although the difference was statistically insignificant ($P > 0.05$) (Table 2). Subjective evaluation by the dentist as well as patient showed Complete dentures provided to patients in both the groups showed improvement in clinical performance with time. But comparison for different parameters at different time interval was statistically insignificant (Tables 3, 4).

Discussion

Loss of teeth in a completely edentulous patient results in a diminished control over the mandibular movements and a shift of mandibular postural position is usually seen in a forward direction. In order to rehabilitate such patients, we need to record the most repeatable position of mandibular closure so that centric occlusion of artificial teeth can be

made to coincide with this most repeatable position of mandibular closure i.e. centric relation [1].

A variation of 0.5–0.1 mm in the centric relation recorded by two methods in most of the cases has been noticed in the present study. Previous studies also indicate gothic CR is more posterior to interocclusal methods [20–22] of recording CR.

However, when clinical performance of the dentures was assessed by dentists as well as patients, the variation was not statistically significant and patient could close the mandible without any deviation. This can be attributed to the resiliency of the basal tissues and the adaptive capacity of the musculature. Hanau refers to this tissue resiliency as realeff, a contraction of the phrase, “resiliency and like effect”. So such a resiliency may help the patient to adapt to slight variations in positional relationships [1].

In this study, condylar guidance angles was recorded at 6 mm of Protrusive movements, as Boucher states it is believe that with a shorter distance, the condyle would not move down its path a distance sufficient to be recorded on the instrument [1, 15]. Condylar guidance angles recorded by Gothic tracings were higher (10–35°) than those measured by interocclusal wax (10–30°) method. Dawson indicate that, condylar inclinations i.e. 25° is seen in majority of the population [23].

A variation of $0 \pm 5^\circ$ was observed between the condylar guidance values measured by the two methods. Craddock [24] stated that a $\pm 5^\circ$ change in condylar guidance would cause a corresponding ± 0.25 -mm change in the molar area. He also suggested avoiding precise measurements; he stated that the sagittal condylar guidance should be considered as “steep, moderate and somewhat flat rather than in terms of degrees of angle.”

Santos [25], Ecker [10], Posselt [12] also showed that extraoral tracing of the sagittal protrusive condylar path gave higher values with less variation than the intraoral wax protrusive method.

Patients adapted well with comparable level of comfort with the dentures fabricated by using different CR and HCG record. Such adaptability can be explained on the basis of laxity of ligaments and adaptability of muscles controlling the mandibular movements and condylar path [1].

Earlier the condylar path was thought to be a fixed factor for an individual and he defied the dentist’s ability to

Table 2 Objective assessment of the variation in the horizontal condylar guidance values recorded by interocclusal wax and the gothic arch method

Horizontal condylar guidance	Number of subjects	Mean of condylar guidance		Mean difference	SE	Probability (P)
		Gothic CG	Interocclusal wax CG			
Right	28	$22.93^\circ \pm 7.15^\circ$	$21.64^\circ \pm 6.24^\circ$	-1°	1.89°	0.6
Left	28	$23.93^\circ \pm 6.9^\circ$	$21.28^\circ \pm 7.02^\circ$	0.35°	1.77°	0.84

Table 3 Subjective assessment of denture quality by the dentist

Parameter	Time interval	Group I (<i>n</i> = 14)				Group II (<i>n</i> = 14)				<i>P</i>
		Grade 4	Grade 3	Grade 2	Grade 1	Grade 4	Grade 3	Grade 2	Grade 1	
Accuracy of centric relation	Initial	12	2			14				0.150
	After 48 h	14				14				1.00
	After 1 week	14				14				1.00
	After 1 month	14				14				1.00
	After 3 month	14				14				1.00
Retention	Initial									
	Maxillary	12	2			12	2			1.00
	Mandibular	8	6			6	8			0.458
	After 48 h									
	Maxillary	13	1			12	2			0.549
	Mandibular	9	5			8	6			0.134
	After 1 week									
	Maxillary	13	1			12	2			0.549
	Mandibular	10	4			9	5			0.691
	After 1 month									
	Maxillary	14				14				1.00
	Mandibular	13	1			12	2			0.549
	After 3 month									
	Maxillary	14				14				1.00
Mandibular	4	10			6	8			1.00	
Stability	Initial									
	Maxillary	14				12	2			0.150
	Mandibular	10	4			6	8			0.134
	After 48 h									
	Maxillary	14				12	2			0.150
	Mandibular	10	4			7	7			0.254
	After 1 week									
	Maxillary	14				13	1			0.317
	Mandibular	12	2			8	6			0.100
	After 1 month									
	Maxillary	14				13	1			0.317
	Mandibular	12	2			10	4			0.366
	After 3 month									
	Maxillary	14				14				1.0
Mandibular	14				12	2			0.153	
Condition of tissue	Initial									
	Maxillary	8	6			10	4			0.439
	Mandibular	4	10			8	6			0.134
	After 48 h									
	Maxillary	8	6			11	3			0.233
	Mandibular	3	11			4	10			0.668
	After 1 week									
	Maxillary	12	2			11	3			0.628
	Mandibular	2	12			4	10			0.366
	After 1 month									
	Maxillary	14				12	2			0.150
	Mandibular	6	8			8	6			0.458

Table 3 continued

Parameter	Time interval	Group I (n = 14)				Group II (n = 14)				P
		Grade	4	3	2	1	4	3	2	
	After 3 month									
	Maxillary	14				14				1.00
	Mandibular	14				14				0.150

Table 4 Subjective assessment of patient satisfaction with dentures

Parameter	Time interval	Group I (n = 14)				Group II (n = 14)				P
		Grade	4	3	2	1	4	3	2	
Patient assessment of stability and retention of upper and lower denture	Initial									
	Maxillary	12	2			14				0.150
	Mandibular	4	10			6	8			0.439
	After 48 h									
	Maxillary	14				14				1.00
	Mandibular	4	10			6	8			0.439
	After 1 week									
	Maxillary	14				14				1.00
	Mandibular	4	10			6	8			0.704
	After 1 month									
	Maxillary	14				14				1.00
	Mandibular	4	10			8	6			0.264
Patient assessment of chewing ability of denture	After 3 month									
	Maxillary	14				14				1.00
	Mandibular	6	8			8	6			0.458
	Initial	2	8	4		4	10			0.06
	After 48 h	4	4	6		4	10			0.133
	After 1 week	3	8	3		6	8			0.086
	After 1 month	8	6			12	2			0.1
	After 3 month	12	2			14				0.15

change it (Mccollum and Stuart [26]). However, Beard and Clayton [27] reported that when tracing the condylar path repeatedly on a pantograph, the tracing deviated. These deviation were explained by Hobo to be due to “buffer spacing” which exists in the glenoid fossa [28]. Buffer spacing allows for condylar mobility and helps to prevent stress. So these mechanisms make up for the slight variations in the condylar inclinations and help patients to adapt comfortably.

Conclusions

On the basis of clinical findings this can be concluded from this study that, the dentures fabricated using the two

different methods were comparable in terms of the accuracy of centric relation, retention and stability, condition of basal tissues as assessed by the dentist; and also the level of satisfaction and chewing efficiency in terms of the patient.

But the procedure involved with the Gothic arch method was found to be more technique sensitive and required greater chair-side time both for the dentist as well as for the patient. Moreover, there were greater chances of incorporation of errors due to mishandling of the device, and fatigue of muscles and jaws from repeated efforts to guide the mandibular movements to produce correct arrow head tracing. On the other hand, the conventional method was found to be more acceptable both for the operator and the patient.

References

- Zarb GA, Bolander CL, Hickey JC, Carlsson GE (1997) Boucher's prosthodontic treatment for edentulous patients, 10th edn. The C.V. Mosby Company, St. Louis, p 283, 270, 422
- Needles JW (1923) Mandibular movements and articulator design. *J Am Dent Assoc* 10:927–935
- Boos RH (1940) Intermaxillary relation established by biting power. *J Am Dent Assoc* 27:1192–1199
- Pyott JE, Schaeffer A (1952) Simultaneous recording of centric occlusion and vertical dimension. *J Am Dent Assoc* 44:430–436
- Shanahan TEJ (1955) Physiologic jaw relations and occlusion of complete dentures. *J Prosthet Dent* 5:319–324
- Donegan SJ, Christensen LV (1991) Sagittal condylar guidance as determined by protrusion records and wear facets of teeth. *J Prosthet Dent* 45:469–472
- Celenza FV (1979) An analysis of articulators. *Dent Clin North Am* 23:305–326
- Swenson MG (1959) Complete dentures, 4th edn. The C.V. Mosby Company, St. Louis, p 166, 167, 382–386
- Pelletier LB, Campbell SD (1991) Comparison of condylar control settings using three methods: a bench study. *J Prosthet Dent* 66:193–200
- Ecker GA, Goodacre CJ, Dykema RW (1984) A comparison of condylar control Settings obtained from wax interocclusal records and simplified mandibular Motion analyzers. *J Prosthet Dent* 51:404–406
- Preti G, Scotti RS, Bruscagin C (1982) A clinical study of graphic registration of the condylar path inclination. *J Prosthet Dent* 48:461–466
- Posselt UP, Franzen G (1960) Registration of the condyle path inclination by intraoral wax records: variations in three instruments. *J Prosthet Dent* 10:441–454
- Trapozzano VR (1955) Occlusal records. *J Prosthet Dent* 5:325–332
- Kingery RH (1952) A review of some of the problems associated with centric relation. *J Prosthet Dent* 2:307–319
- Payne SH (1995) Selective occlusion. *J Prosthet Dent* 5:301–304
- Niswonger ME (1934) The rest position of the mandible and the centric relation. *J Am Dent Assoc* 21:1572
- Rahn AO, Heartwell MC (1993) Textbook of complete dentures, 5th edn. Lea & Febiger, USA, pp 193–290
- Swenson MG (1959) Complete dentures, 4th edn. The C.V. Mosby Company, St. Louis, pp 382–386
- Woelfel BJ, Paffenbarger GC, Sweeney WT (1965) Clinical evaluation of complete dentures made of different types of denture. Base materials. *J Am Dent Assoc*. 70:1170
- Walker RC (1962) A comparison of jaw relation recording methods. *J Prosthet Dent* 12:685–694
- Kantor ME, Silver SI, Garfinkel L (1973) Centric relation recording techniques: a comparative investigation. *J Prosthet Dent* 30:604–606
- Smith HF (1975) A comparison of empirical centric relation records with location of terminal hinge axis and apex of the Gothic arch tracing. *J Prosthet Dent* 33:511–520
- Dawson PE (1989) Evaluation, diagnosis and treatment of occlusal problems, 2nd edn. CV Mosby Company, St. Louis, p 214
- Craddock FW (1949) The accuracy and practical value of records of condyle path inclination. *J Am Dent Assoc* 38:697–710
- Santos JD, Nelson S, Nowlin T (2003) Comparison of condylar guidance setting obtained from a wax record versus an extra oral tracing. A pilot study. *J Prosthet Dent* 89:54–59
- Mccollum BB, Staurt CE (1955) A research report. Scientific press, California
- Beard CC, Clayton JA (1975) Electronic PRI consistency in diagnosis temporomandibular joint dysfunction. *J Prosthet Dent* 55:255–259
- Hobo S, Takayama H (1997) Oral rehabilitation: clinical determination of occlusion, 1st edn. Quintessence Publishing Co., Inc., Tokyo 8