

# Recording Condylar Guidance: Are We Getting It?

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**Abstract**

The purpose of using a semi-adjustable articulator is to simulate the patient's mandibular movement and help in restoring functional occlusion. Condylar guidance on the articulators is an approximate duplication of the condylar path in patients. Many concepts regarding the condylar guidance have been discussed and evaluated, but no single or definite method of recording this value has been put forward. An extensive electronic search was conducted from 1991 until December 2016 to narrow down studies based on interocclusal records for recording the condylar guidance. Our results demonstrate heterogeneity in the condylar guidance values in the selected studies. Materials used for interocclusal records, the type of articulators and the facebow technique influence the values of condylar guidance.

**Key Words:** Condylar Guidance, Articulators, Interocclusal records, Centric Relation, Extra oral Methods

## Introduction

The temporomandibular joint (TMJ) is a synovial joint that allows a range of movements for functions such as speech, suckling, swallowing and mastication. The human condyle, a part of TMJ, is capable of movements such as rotation and translation in the three coordinate planes. The path traversed by the condyle in relation to the articular eminence often called as the condylar path, occurs when the mandible moves either protrusively or laterally from centric relation.

The purpose of using a semi-adjustable articulator is to simulate the patient's mandibular movement and help in restoring functional occlusion. Condylar guidance is a mechanical form present in the articulator and is mostly controlled by its upper posterior mobile part<sup>1</sup>. The difference between human condyle and condylar guidance in the articulator can be elicited in Fig 1. Condylar guidance on articulators is an approximate duplication of the condylar path in patients that is reproduced with interocclusal or

transfer records. Such transfer records are done either directly by hinge axis records, pantographic records to articulator or by radiographic methods. For example, protrusive jaw relations are recorded to set the condylar elements of the articulator to reproduce inclinations, similar or comparable to that of the

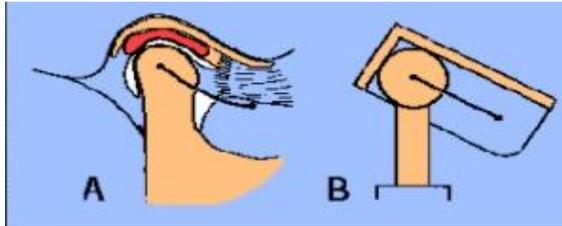
patient's guidance. Thus, we need to realize that the accuracy of the derived occlusion in a patient is determined by the reliability and precision of the methods used for programming the articulators.

## Recording Condylar Guidance Accurately – Are We Getting It?

Many concepts regarding the condylar guidance have been discussed and evaluated by various authors, but no single or definite method of recording this value has been put forward. Therefore, the concept whether to record the condylar guidance or not is an interesting debate.

The importance of condylar guidance was first put forward by Hanau. According to him, the condylar guidance contains (a) an anteroposterior guidance (horizontal inclination); (b) a lateral guidance (sagittal inclination), and (c) a lateral aberration. Specifically, excursions of the condyle head in the condylar fossa can be explained in terms of (i) the forward and downward directed excursion along the protrusive guidance, the inclination of which is expressed by the angle to a horizontal plane (horizontal inclination); (ii) the forward, downward and inward directed excursion on the balancing side along the lateral guidance, the inclination of which is referred to the sagittal plane (sagittal inclination), and (iii) the lateral excursion on the working side, the lateral

aberration which deviated slightly from a perpendicular to the sagittal plane. Hanau also states the importance of condylar guidance in achieving balanced occlusion<sup>2</sup>.



**Fig.1 (A) Human temporomandibular joint (B) Condylar guidance**

Gysi interestingly states that it is practically impossible to get consistent condylar registration differing from 5 degrees to 25 degrees above or below the individual condition raising doubts on the accuracy of condylar guidance that we routinely record on a semi adjustable articulator<sup>3</sup>.

Craddock described the practical value of recording condyle path inclination. He stated the use of intraoral wax records of eccentric jaw relations for horizontal condylar guidance adjustments on anatomic articulators had been shown to be invalid and unreliable. He also stated that generally, an average type articulator with condylar guidance fixed at 30 degrees can be utilized for all patients whose actual condylar guidance falls between 25 and 35 degrees approximately, with a resulting error of 0.25 mm or even less in the balancing contact of the molars. It may be highlighted that if fixed condylar guidance is to be employed in practice, there is some justification for making it slightly steeper rather than flatter than the average of 30 degrees, for then the actual guidance of most patients will be flatter than that of the articulator. Under these circumstances, when the finished dentures are placed in the mouth and tested for eccentric occlusion a slightly heavy or premature contact of the molars, may be detected and corrected, by spot grinding of the balancing contacts. The reverse arrangement would necessitate grinding of the anterior teeth which can result in a change of esthetic plane<sup>4</sup>.

So an intriguing question that reports up is are we

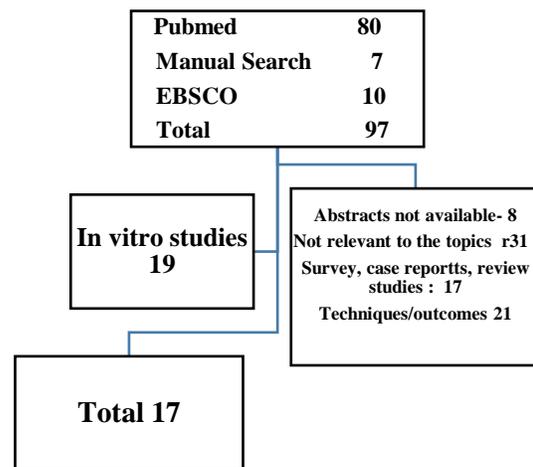
getting the factual condylar guidance angles? Are there any factors that affect condylar guidance while recording it? We intend to address these questions by determining the studies conducted so far on recording condylar guidance and the review the factors affecting the condylar guidance values.

### Methodology

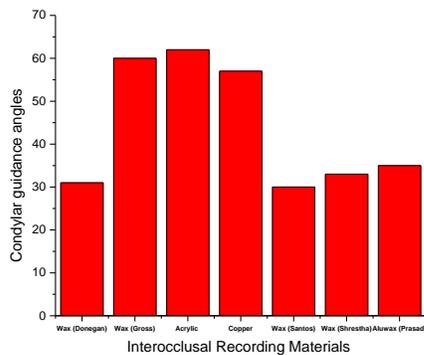
All experimental studies done from 1991 to December 2016 on human condylar guidance on two major health science databases (PubMed, EBSCO), using the search strategy of various key terms in different permutations of Condylar Guidance, OR Articulators, OR Interocclusal records, OR Centric Relation, OR Extra oral Methods were looked at. The study selection flow chart is shown in Figure 2.

### Results

Studies on determining the condylar guidance angles using interocclusal records and different articulators have been presented in Table 1. Due to a large number of confounding factors, a graphical representation of interocclusal records is presented in Fig 3.



**Fig.2 Flowchart of Selection of Article**



**Fig. 3 Effect of interocclusal recording materials on condylar guidance**

### Discussion

In a comprehensive prosthodontic treatment or when there is a requirement of an occlusion analysis, a centric condylar positions are generally recorded. Despite using different methods of registration, there is no single suggested method yet.

A share of heterogeneity could be concluded from the studies conducted on condylar guidance. Factors such as materials used for interocclusal records, the type of articulators used, and the facebow techniques influence the values of condylar guidance. As shown in Fig 3, it is seen that acrylic records provided high values of condylar guidance, followed by wax records. In the following paragraphs, an in depth discussion on the condylar guidance obtained using different methods will be presented.

Donegan et al determined the sagittal condylar guidance using a protrusive wax interocclusal record and matching wear facets of opposing canines and contralateral molars and found significant differences between the mean angles of the two methods  $-31^{\circ}$  (protrusion record) and  $+24^{\circ}$  (wear facets)<sup>5</sup>.

Gross et al checked the effect of three different recording materials on the reproducibility of condylar guidance registrations in three semi-adjustable articulators. Significant difference in condylar guide settings were found between pink base plate wax, acrylic and copper wax protrusive and laterotrusive occlusal registrations, which

were clinically irrelevant. None of the single recording materials gave consistent results. Significant differences were found between Denar Mark II® giving the highest registrations and Hanau 158® the lowest. High levels of variability were seen in condylar guidance between the materials and the articulators<sup>6</sup>.

Utz K H et al found the unrefined wax wafer registration better than acrylic wafers. The centric based point and frontal jig methods, tin-foil and refined wax wafers showed intermediate values. The biggest measured mandibular displacement between any two registrations were considerably 2.0 mm<sup>7</sup>. Another study by Santos Je et al investigated and compared the condylar inclination angles by use of wax protrusive records, pantographic tracings and occlusal wear facets, and concluded that the measurement of the extra oral tracing of the sagittal protrusive condylar path gave higher values with less variation than the intraoral wax protrusive method<sup>8</sup>.

Shrestha et al found higher Horizontal Condylar Guidance (HCG) values with CT scan recording than the clinical methods<sup>9</sup>.

Thakur et al compared the static and functional method for recording centric relation and condylar guidance. 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<sup>10</sup>. Torabi K et al studied the difference in recording HCG with the Cadiax Compact II system, a computerized recorder of condylar inclination with intraoral records using wax and addition silicone. They found out that statistical differences between Cadiax and intraoral records were found to be more significant for Bennett angle than for sagittal condylar inclination. Intraclass correlation coefficient showed more consistency between silicone registration material and Cadiax records<sup>11</sup>.

**Table 1 Literature review of recording of condylar guidance using different methods**

<b>INTEROCCLUSAL RECORDS</b>					
<b>Year</b>	<b>Authors</b>	<b>Method</b>	<b>Type</b>	<b>Findings</b>	<b>Results</b>
1991	Donegan et al <sup>5</sup>	Wax records; wear facets	In vivo	Significant difference in mean angles with both methods	31° in protrusive records and 24° - wear facets
1998	Gross et al <sup>6</sup>	3 recording materials (Wax,Acrylic,Copper); articulators (Whip mix, Hanau 158, Denar Mark II)	In vitro; 2 edentulous subjects	Variable results with different materials and articulators	Materials: Protrusive R:Wax= 60.23: 59.09; Acrylic=62.06: 73.90, Copper=57.40:60.11  Mean differences between materials were 3°and 6°  Order of condylar guidance was more in Denar, Whipmix and Hanau
2002	Utz K H et al <sup>7</sup>	CBP-registration, tin-foil wafer, acrylic wafer, frontal jig registration, plain wax wafer, refined wax wafer (Dentatus)	In vivo; 80 dentate subjects	All investigated registration methods provided similar outcomes with an median spacial accuracy of 0.3 mm.	Registration of condylar position differed with more than 2mm
2003	Santos Je et al <sup>8</sup>	Wax records(modelling wax); pantographic tracings; wear facets (Hanau Wide Vue)	In vivo 10 dentulous patients	High values with less variation with wax records; extraoral methods captured condylar guidance from most retruded position of condyle	Wax protrusive records : 29.80°± 9.25; Pantographic tracings : 38.30°±6.98
2012	Shreshtha P et al <sup>9</sup>	CT scan; interocclusal methods (modelling wax/ lucia jig, intraoral tracers)  ( Protar 7 )	In vivo 12 dentulous patients	CT scan showed higher HCG values that the clinical methods	HCG values (R) : 43.83 ± 6.57 (CT), 33.33 ± 7.75(wax), 29.16 ± 6.77(jig), 31.25 ± 7.42 (tracer)  HCG values (L) : 42.42 ± 6.06(CT), 33.64 ± 7.94(wax), 30.56 ± 7.02(jig), 30.83 ± 6.68(tracer)
2012	Thakur M et al <sup>10</sup>	Static and functional methods (Hanau Wide Vue)	In vivo; 28 edentulous subjects	Level of patient satisfaction and chewing efficiency were also checked	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

2014	Torabi K et al <sup>11</sup>	Cadiax Compact II system; wax and addition silicone records	In vivo; 22 dentulous subjects	Intraclass correlation coefficient showed more consistency between silicone registration material and Cadiax records	CG with Cadiax and wax : -2.68±4.25(R); -2.50±5.11(L) CG with Cadiax and silicone : 1.50±2.50(R); 1.22±2.67(L)
2016	Prasad K D et al <sup>1</sup>	Protrusive occlusal records (Aluwax); panoramic radiographs (Hanau Wide Vue)	In vivo; 75 edentulous subjects	Panoramic radiographic tracing may be made relative to frankfort's horizontal reference plane	Condylar guidance obtained using aluwax is 34.7 (R) and 35 (L) & radiography is 36.68® and 38.1(L)
2015	Veloso et al <sup>12</sup>	Static (modelling wax)and dynamic registrations in patient compared with cone beam radiography for condylar position	In vivo; 20 edentulous subjects	Dynamic registration is more reliable and accurate method of use	Condylar position in articular fossa after static and dynamic registration, condylar position in articular fossa after static and dynamic registration and the relation between articular eminence and condylar guidance were compared and concluded that Dynamic registration seems a reliable and an accurate method to use.

**ARTICULATORS & FACEBOWS**

1993	Steven R et al <sup>13</sup>	Magnetic resonance imaging, articulator mounted casts	In vitro	Condylar concentricity was observed in half of the sample and remained consistent in retruded position of the condyle, centric occlusion, and centric relation	Validity coefficients between MRI and articulator: In centric occlusion- left horizontal: -0.18; right horizontal: 0.55
2003	Cynthia S et al <sup>14</sup>	Computerized axiography; mechanical pantography	In vitro; 10 subjects	High scores with pantographic tracings	Coefficients of stability between the initial and second recordings were r =0.91 for mechanical pantography and r = -0.06 for computerized axiography
2012	Shetty P et al <sup>15</sup>	Panoramic radiographs; interocclusal records during jaw relation and try-in (Hanau Wide Vue)	In vivo; 15 edentulous subjects	Condylar guidance angle varies with the stage at which it was recorded	Mean CG values (R) : 12.73±11.08 (jaw relation); 37.13±5.40 (radiograph); 24.00±11.83 (try-in)  Mean CG values (L) : 13.47±9.87 (jaw relation); 35.13±4.79 (radiograph); 21.67±10.63 (try-in)

2013	Prajapati et al <sup>16</sup>	Arcon and non-arcon articulators	In vitro; 15 edentulous subjects	Arcon type articulator simulates the mandibular movements of the patient	The statistical result of the test are not significant for all three points  of reference used in the study for both the Arcon and the Non-Arcon articulator used in the study
2011	Goyal et al <sup>17</sup>	Direct and indirect facebow transfer	In vivo; 15 edentulous subjects	Mean HCG values obtained from indirect facebow transfer were more than those obtained from direct facebow transfer	Mean HCG values in direct face-bow transfer : 24.93°, indirect transfer : -27.66°, cephalometric analysis : -32.73°
2014	Mishra et al <sup>18</sup>	Facebow transfer; lateral cephalogram	In vitro; 15 dentulous subjects	Lateral cephalogram gave higher value of HCG; values obtained from indirect facebow transfer were closer to those obtained from lateral cephalogram	Mean HCG values obtained in direct face-bow transfer : 24.93°, indirect transfer : -27.66°, cephalometric analysis : -32.73°
2015	Bhawsar et al <sup>19</sup>	Hanau formula; kinesiograph	In vivo; 20 edentulous subjects	Reassessment of current average settings and use of hanau formula for programming the articulators by the dentists and technicians	CG values obtained using the Hanau's formula : 14-17°; computerized K7 jaw tracking device : 8-40°

**X RAY IMAGING TOOLS**

2008	Gilboa I et al <sup>20</sup>	Articular morphology in dry skulls; panoramic radiography	In vitro; 25 human skulls	Panoramic imaging consistently replicated the articular eminence in skulls	Significant correlation between the sagittal inclination and the corresponding panoramic radiographic image for both right (R=0.802; P=.001) and left (R=0.561; P=.004) sides
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Veloso L et al compared the condylar position in the articular fossa after static and dynamic registration, analyzed the symmetry between right and left condyles and examined the relationship between articular eminence and condylar position. They concluded that the dynamic registration was more reliable and accurate method. With the higher condylar symmetry and the centered position in articular fossa, it seemed to have reproduced a physiologic condylar position<sup>12</sup>.

Prasad K D et al evaluated the correlation between sagittal condylar guidance obtained by protrusive interocclusal records and panoramic radiograph tracing methods relative to the Frankfurt's horizontal reference plane and found the condylar guidance can be used to set the condylar guide settings of semi adjustable articulators<sup>1</sup>.

### Conclusion

Search strategy results show only about seventeen in vivo studies of dentulous and edentulous subjects on recording condylar guidance. There is heterogeneity in the condylar guidance values in the presented studies. Materials used for interocclusal records, the type of articulators and the facebow technique influence the values of condylar guidance.

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