Original Article

Comparative evaluation of hight tracer, Chandra tracer, intraoral tracer, functiograph and checkbite: A clinical study

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Purpose: Centric and eccentric relations of mandible can be recorded through check bites, graphic recordings, functional recordings and cephalometrics. These records are then transferred to a semi-adjustable articulator so that it can be set to simulate the human system. This study is an attempt to compare the relative accuracy of the checkbite and graphic recordings using cephalometrics as a standard.

Aims:

- To compare the efficiency of hight tracer, Chandra tracer, Conventional intraoral tracer, Functiograph and Checkbite in determining centric relation.
- To compare the efficiency of hight tracer, Chandra tracer, Conventional intraoral tracer, Functiograph and Checkbite in determining horizontal condylar guidance angle on Hanau H2 articulator with the aid of both centric and eccentric records.
- To compare the horizontal angle values thus obtained on the Hanau H2 articulator with horizontal angle values in cephalometric tracings.

Materials and Methods: Hight tracer, Chandra tracer, Conventional intraoral tracer, Functiograph and Checkbite were used on 10 edentulous subjects to obtain centric and protrusive records. Lateral cephalograms were made at both centric and protrusive positions with each method and the horizontal condylar values thus obtained were compared with those obtained on Hanau H2 articulator.

Results:

- There was no statistical difference between the cephalometric and articulator values in all the five experimental methods.
- There was no significant difference between Hight tracer, Chandra tracer, Intraoral tracer, Functiograph and Checkbite methods.
- Ranking the experimental methods in the order of efficiency: the first was the Intraoral tracer, second being Functiograph followed by Chandra tracer, Checkbite and Hight tracer.
- Checkbite alone can be used to set the horizontal angles on the articulator in edentulous subjects, clinically.
- Tracings can be used as a verificatory method.
- Centric relation position was found to be the same in a subject with all the experimental methods.
- Each experimental method can influence the condylar path differently in the eccentric position.

Conclusions: The articulator value of horizontal condylar angle was higher than cephalometric value in majority of the subjects in all the five experimental methods.

Key words: Centric relation, interocclusal record, jaw relation record

Articulators are used to relate the maxilla with the mandible and to simulate functional movements. For this, the articulator should be set according to the patient's horizontal condylar angle. Eccentric border position of the mandible is registered to adjust the horizontal condylar angles in the articulator. Checkbites, graphic tracings, functional recordings and radiographs are used to ascertain and register the centric and eccentric positions.[1]

Kapur and Yurkstas[2] compared the duplicability

of centric records obtained using extraoral tracing, intraoral tracing and wax registrations. It was found that all the methods were consistent and wax registration method was found to be the least reliable. However, they concluded that the difference that existed between the methods ranged from 0.2 to 0.4 mm, which is barely perceptible clinically. In this study, comparison was made between the methods without using radiographic standards and only centric relation records were subjected to scrutiny. The present study is an attempt to compare different methods used to register the horizontal condylar angle. Cephalometric values were used as a standard. The different methods used were hight tracer, Chadra tracer, intraoral tracer, functiograph and checkbite.

METHODOLOGY

Ten edentulous subjects requiring complete dentures were selected randomly for this study. The study group included six males and four females of age ranging from 48 to 65 years. Individuals having restricted and deviated mouth opening, clicking, pain or tenderness of the temporomandibular joint were excluded.

Impressions were made using conventional techniques and master casts were prepared using dental stone. Maxillary and mandibular permanent denture bases were fabricated on the master casts using heat cure acrylic resin. The denture bases were trimmed and polished and casts were prepared out of them. Occlusion rims were then prepared and were adjusted in the patient's mouth to register the maxillo-mandibular relations. Using facebow transfer, the maxillary cast was mounted on the Hanau H2 articulator. Tentative centric relation was then registered at the conventionally established vertical dimension. Four millimetres of Freeway space were adopted as a standard in all the cases. Mandibular cast was mounted in the articulator using this tentative registration. The objective of the study required verification of the centric relation using four tracing devices and obtaining protrusive records. In order to use a standard occlusion rim for all the tracers, the following procedure was adopted. A line was drawn on the mounting plaster parallel to the occlusal plane at a known distance. The line was used to verify the height of the occlusion rim on future replication. The base with the occlusion rim was then embedded in putty silicone to form an index, which enabled the replication of occlusion rim on subsequent uses [Figures 1-3]. First, the experiment was completed with one tracer and then the occlusion rim was fabricated again using the putty index, and the second tracer was then fixed onto it. The experiment was completed subsequently following the same procedure.

The tracers used in the study were discussed in the following sections.

Hight tracer

The hight tracer[3] is a four-component assembly, which consists of an upper bearing plate, lower bearing plate with a central screw, a scriber point to be attached to the upper rim and a tracing platform which extends 3 in. forward and is attached to the lower rim [Figure 4]. The upper bearing plate was heated and waxed to the maxillary rim, making it flush with the occlusal plane. The lower occlusal rim was reduced by 3 mm and the lower plate was firmly luted to the mandibular rim to avoid any interference during jaw movements. The scriber was attached to the maxillary rim and lower tracing platform was waxed to the mandibular rim. The upper and lower tracers were made parallel. The vertical height was maintained by adjusting the central bearing screw. The tracing table was covered with permanent marker ink and the subject was made to perform protrusive and lateral movements repeatedly till a Gothic arch tracing with sharp apex was obtained. After satisfactory tracings were obtained, quick setting plaster was injected between the rim and was allowed to set, while the scriber point rested on the apex of the arrow point tracing. A plastic sheet with a hole corresponding to

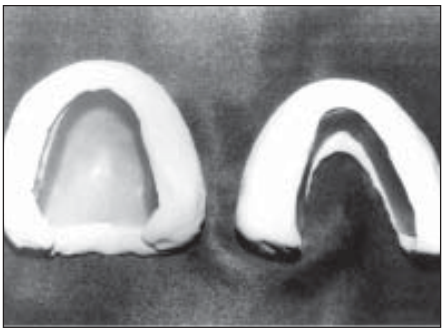


Figure 1: Record bases embedded in silicone putty

Figure 2: The silicone putty index

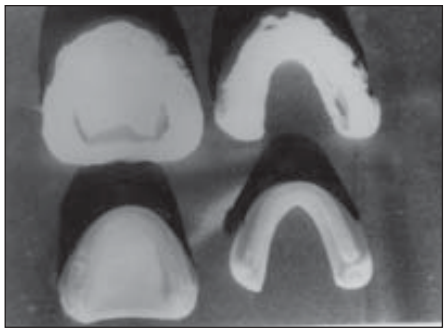


Figure 3: Maxillary and mandibular occlusion rims fabricated on the same denture bases using putty index

the apex was mounted over the platform of the tracer. Subject was asked to hold the pin in the hole during the process. A protrusive record was then obtained in the protrusive tracing at a point, 6 mm away from the apex.[4] Plastic sheet with the drilled hole was used to stabilize the position. This centric record was used to verify the tentative relation and the protrusive record was used to set the horizontal condylar angle [Figure 5].

Chandra tracer

The Chandra tracer is a two-component assembly (K. Chandrasekharan Nair, personal communication). The upper bearing plate has a pencil holder and the lower bearing plate has a central bearing screw and tracing platform of dimensions 35 × 47 mm, which had pins to hold a drawing sheet. A sharp pencil was attached to the upper component [Figure 6]. The tracings obtained could be preserved for subsequent use. The occlusal rims were made on the same bases following the above-mentioned guidelines. Upper plate was attached flush with the occlusal plane and the lower occlusion rim was reduced by 3 mm to provide space for the interocclusal record. The tracer was placed in the mouth and tracings were recorded on the paper fixed to the table. After many repetitions, the best tracing was selected and the centric and protrusive plaster records were obtained using quick setting plaster [Figure 7]. A point, 6 mm away from centric on the protrusive tracing was selected for making the protrusive record. Plastic sheets were used for stabilization during the recording. The centric record was used for verification and the protrusive record was used to set the horizontal condylar angle of the articulator.

Intraoral tracer

The tracer consisted of an upper bearing plate and a lower bearing plate with a screw and scribing point at the centre [Figure 8]. The occlusal rims were fabricated again using the putty index and the tracer was mounted on the rims after the mandibular rim was reduced by 3 mm. The pin was adjusted to contact the plate at the correct vertical dimension. The upper plate was coated with permanent marker ink. The rims were placed in the mouth and the subject was asked to carry out the eccentric movements. After many such movements, tracings were examined. Once a clear apex was obtained, a small plastic sheet with a central hole was mounted with the hole coinciding with apex. This was attached to the tracing plate with sticky wax. Subject was made to move the jaw until the pin fell into the hole and quick setting plaster was injected in between the rims. Centric record was thus obtained. Protrusive record was made at a point 6 mm away from the apex in the protrusive path [Figure 9]. Centric relation was verified using the centric record. The protrusive record was placed on the articulator

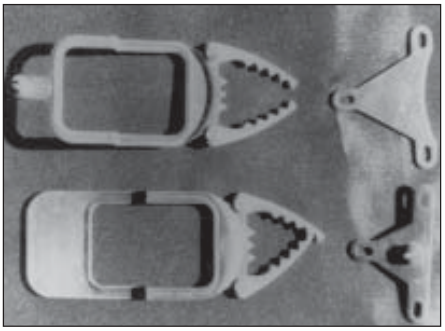


Figure 4: The hight tracer

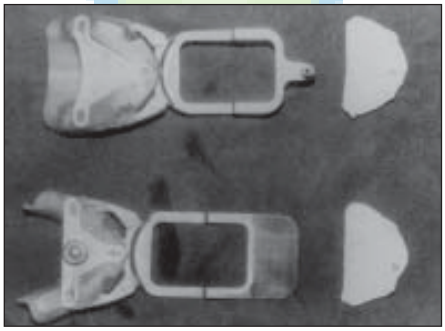


Figure 5: Centric and protrusive records obtained using hight tracer

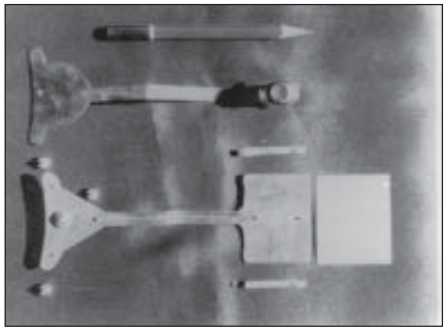


Figure 6: The Chandra tracer

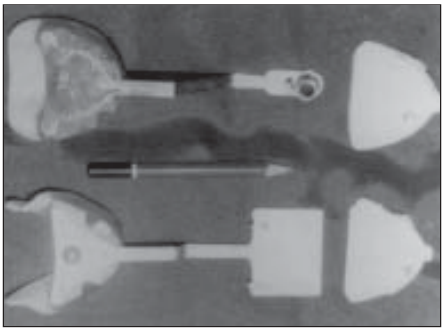


Figure 7: Centric and protrusive records obtained using Chandra tracer

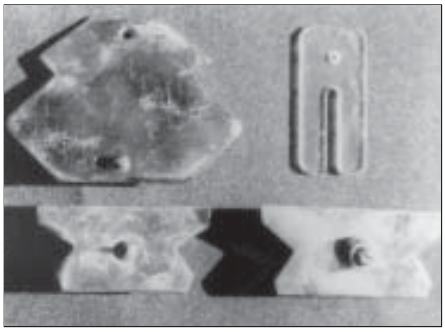


Figure 8: The intraoral tracer

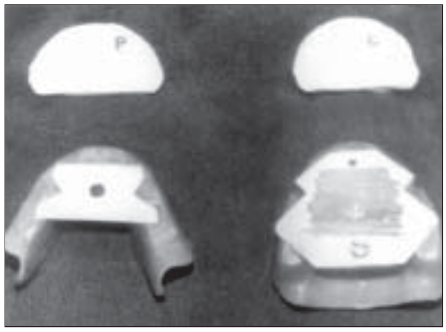


Figure 9: Centric and protrusive records obtained using intraoral tracer

and the horizontal condylar reading was obtained.

Functiograph

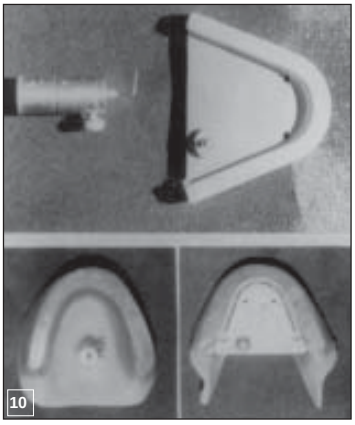
The functiograph[5] instrument manufactured by M/s Ivoclar, Lilchtenstein, Switzerland, has mainly two parts - a marking pin or the universal printer and a tracing plate [Figure 10]. The marking pin is attached to the maxillary denture base using auto-polymerizing acrylic resin. The tracing plate is a smooth metallic plate accommodated in the lingual region of the mandibular teeth. It is available in two sizes: a U-shaped plate and a slightly larger triangular plate, to fit into different shaped arches. It is adapted to the acrylic resin plate by means of a plastic splint that is available in two sizes to match the metallic recording plates. The splint has a channel running all along its length, which holds the margin of the metallic plate. The occlusal rims were fabricated again using the putty index and the functiograph was mounted on the rims, after the mandibular rim was reduced by 3 mm. The tracing plate was coated with permanent marker ink. The rims were placed in the mouth and the subject was asked to carry out the eccentric movements. After many such movements, tracings were examined. Once a clear apex was obtained, a small plastic sheet with a central hole was mounted with the hole coinciding with the apex. This was attached to the tracing plate with sticky wax. Subject was made to move the jaw until the pin fell into the hole and quick setting plaster was injected between the rims. Centric record was thus obtained. Protrusive record was made at a point 6 mm away from the apex in the protrusive tracing [Figure 11]. Centric relation was verified using the centric record. The protrusive record was placed on the articulator and the horizontal condylar reading was obtained.

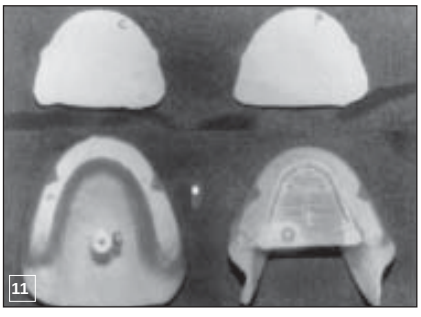
Checkbite

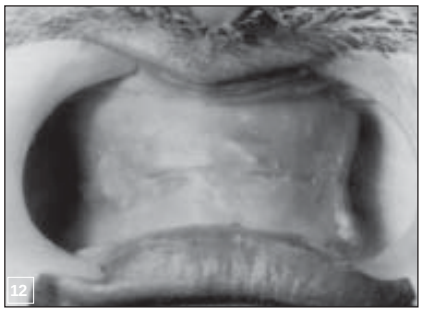
Checkbite method was tried to apply on all patients. The occlusal rims were re-established to the same vertical dimension and two notches were prepared on the maxillary and mandibular rims in the premolar region, one on each side. Petrolatum was smeared into the notches. Softened wax ribbons of 3-mm thickness were placed on the mandibular rim and the centric record was obtained. The subject was then asked to protrude the mandible as much as possible to obtain the protrusive record [Figure 12]. Centric relation was verified using the centric record and the protrusive record was transferred to the articulator and the horizontal condylar angle was read from the articulator. Horizontal angle could be read in the Hanau articulator through the graduations provided, but each division corresponds to 5°. In order to obtain the reading corrected to 1°, a template was prepared and was fixed over the condylar housing while reading the angles [Figure 13].

Cephalometric examination

One lateral cephalogram was taken in the centric relation position and another in the protrusive position with the tracers in the mouth. To avoid discrepancies in natural head position in the two cephalograms, the subject was asked to look into the image of his/







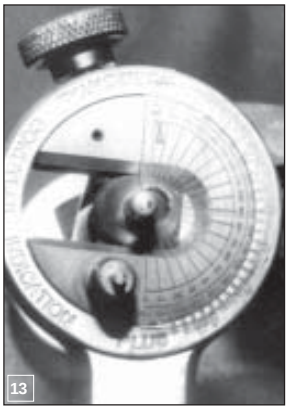


Figure 10: The functiograph. **Figure 11:** Centric and protrusive records obtained using the functiograph. **Figure 12:** Protrusive checkbite on the patient's mouth. **Figure 13:** Template used to obtain horizontal condylar angles

her own eyes in a vertical mirror fixed on to the cephalostat directly in front of the patient.[6]

Lateral cephalogram was exposed at 15 mA, 86 kVpulse for 1.25 s. Cephalometric tracings were made on tracing films. Frankfort horizontal plane was drawn connecting the superior most point on the external auditory meatus (porion) to the lower most point on the lower orbital rim (orbitale). The posterior and superior most point on the condyle, condylion, was traced onto a tracing film from the centric relation cephalogram. The protrusive relation cephalogram was superimposed onto the tracing film and condylion was marked. A line was drawn joining these two points. It was projected to meet the Frankfort horizontal plane. The angle between these two lines gave the horizontal condylar angle. This was compared with the value read on the articulator with the same tracer. The same procedure was repeated with all the methods.

The data were analysed by (1) computing mean and standard deviation (the equality of means was tested using the Student's *t*-test), (2) the homogeneity of different methods was tested with the help of 'One analysis of variance (*F*-test)' and (3) Pearson's correlation co-efficient '*r*' was determined to find out the strength of association between the articulator and cephalometric measurements.

RESULTS

The results of the study are presented in Tables 1-6. The horizontal condylar angle values recorded by the Hanau H2 articulator with hight tracer, Chandra tracer, intraoral tracer, functiograph and checkbite are presented in Table 1. Values ranged from 10 to 32° in hight, from 10 to 33° in Chandra, from 8 to 32° in intraoral, from 9 to 33° in functiograph and from 8 to 34° in the checkbite method. In five subjects, articulator values were equal in at least three methods and in five subjects at least two methods showed coincident values. Homogeneity of the data obtained was tested statistically by *F*-test (ANOVA) [Table 2].

It was found that the horizontal condylar angle obtained from these five methods were not different statistically. When the horizontal condylar angle values obtained in cephalometrics was compared as in Table 3, again it was found that the values obtained from different methods were almost similar [Table 4]. In one subject, four methods showed identical values while in two subjects, three methods produced similar values. In the other seven cases, at least two methods gave identical values.

Table 5 shows the differences between the articulator and radiographic values keeping the latter values as the standard. The highest mean difference was

Table 1: Comparison of horizontal condylar angles (in degrees) obtained in Hanau H2 articulator with different experimental methods

Case No.	Hight	Chandra	Intraoral	Functiograph	Checkbite
1	10	12	10	9	13
2	30	30	30	28	32
3	20	21	20	20	25
4	19	19	20	19	23
5	10	10	8	9	8
6	20	20	20	19	25
7	32	33	32	33	34
8	18	19	19	17	19
9	24	22	21	22	20
10	21	21	20	20	23

Table 2: Anova table to test the homogeneity of different methods according to articulator values as referred to in Table 1

Source of variation	Sum of squares	Degree of freedom	Mean sum of squares	*F*-ratio	*P*-value
Between methods	39.68	4	9.92	0.18	>0.05 (NS)
Within methods (error)	2432.5	45	54.05		
Total	2472.18	49			

Table 3: Comparison of horizontal condylar angles (in degrees) obtained in cephalograms with different experimental methods

Case No.	Hight	Chandra	Intraoral	Functiograph	Checkbite
1	12	12	8	10	12
2	27	28	28	25	30
3	18	18	20	20	22
4	18	19	21	19	22
5	8	9	8	8	8
6	21	19	19	18	22
7	30	31	31	31	30
8	17	19	18	18	19
9	20	20	21	21	25
10	20	19	20	18	20

Table 4: Anova table to test the homogeneity of different methods according to cephalometric values as referred to in Table 3

Source of variation	Sum of squares	Degree of freedom	Mean sum of squares	*F*-ratio	*P*-value
Between methods	29.12	4	7.28	0.16	>0.05 (NS)
Within methods (error)	2043.3	45	45.41		
Total	2072.42	49			

Table 5: Comparison of horizontal condylar angles (in degrees) obtained in the articulator and cephalograms for the different experimental groups

Case No.	Hight	Chandra	Intraoral	Functiograph	Checkbite
1	-2	0	+2	-1	-1
2	+3	+2	+2	+3	+2
3	+2	+3	0	0	+3
4	+1	0	-1	0	+1
5	+2	+1	0	+1	0
6	-1	+1	+1	+1	+3
7	+2	+2	+1	+2	+4
8	+1	0	+1	-1	0
9	+4	+2	0	+1	-5
10	+1	+2	0	+2	+3
Mean difference	+1.3	+1.2	+0.6	+0.8	+1.2

observed with hight tracer followed by Chandra tracer, checkbite, functiograph and intraoral tracer in the descending order. ANOVA table [Table 6] was used to test the homogeneity of the difference between articulator and radiographic values according to different methods. The ANOVA turned out to be insignificant, so it is proved beyond doubt that the difference between articulator and radiographic values is statistically negligible.

Table 6: Anova table to test the homogeneity of different methods according to cephalometric values as referred to in Table 5

Source of variation	Sum of squares	Degree of freedom	Mean sum of squares	*F*-ratio	*P*-value
Between methods	4.12	4	1.03	0.38	>0.05 (NS)
Within methods (error)	121.80	45	2.71		
Total	125.80	49			

DISCUSSION

Accurate recording of centric relation requires the backing of a clear conceptual understanding. Patient can be guided to the centric position through instructions, tongue retrusion, swallowing technique, relaxation or temporalis muscle check; and then the position is registered. The accuracy of registration can be verified by the Gothic arch tracing that can be obtained either intraorally or extraorally. The apex of the Gothic arch denotes the centric relation position, which can be of immense help to a novice whereas an experienced professional can go by his/her judgement of the relation. Both the popularly used checkbite method and the academically exercised tracing devices are important for the profession but their relative accuracy is to be ascertained. In the present study, two extraoral, two intraoral tracers and the checkbite were compared. Denture bases were fabricated from heat polymerizing acrylic resin to obtain accurate fit and the height of the occlusion rims was standardized using a silicone putty index. Plaster was used to make interocclusal records as it is considered the material of choice. The thickness of the interocculusal record was kept at 3 mm. Centric and protrusive records were obtained with each method, the tentative centric relation was verified using these records. Whenever any discrepancy occurred, the record was repeated and the lower cast was remounted. The protrusive record was then placed on Hanau H2 articulator and the horizontal condylar angles were read from the articulator using a template. Articulator setting of horizontal angle was repeated thrice and from amongst the three readings, two coincident readings were considered to fix the condylar path. The cephalometric value obtained was compared with the one obtained in the Hanau H2 articulator.

The horizontal angles obtained using cephalometrics were lesser than those on the articulator, which means that the anatomical values are actually lesser. However, when the different methods were compared, not all the cephalometric values were lesser than the articulator values [Tables 1 and 3]. This can be attributed to the limitations in the use of cephalometrics. To minimize errors from any change in head position, a standardized procedure was followed. An interesting finding of the study is that different methods gave different cephalometric readings of horizontal angle for the same patient though at least two methods showed identical values. However, the centric relation position was found to be the same in all the methods. The difference in horizontal angle observed in cephalograms for the same individual when different methods were used can be due to the influence of anterior guidance and condyle being taken as the measuring parameter. Different methods experimented influenced the condylar path independently. This is in agreement with the view of Ogawa et al.[7] This raises the question as to whether we must consider posterior guidance as immutable.

The study was started with an aim to compare the efficacy of different tracers and checkbite. Fixation of the hight tracer was a tedious procedure with the resultant loss of registered labial fullness and buccal corridor. Another problem with the hight tracer was that the tracing could not be stored and if the subject was tired and was unable to give a good tracing, we could not go back to the original one. The only option was to dismiss the subject and schedule another appointment. Chandra tracer was designed to overcome this drawback in particular and to make tracing a simpler procedure in general. Here, drawing sheets were used for tracings and hence the tracings could be stored. The other advantage was that Chandra tracer, being a two-component assembly, saved time during tracer fixation. The advantage with the intraoral tracers was that the tracing apex was achieved easily, as the tracing plates were closer to the temporomandibular joints. The disadvantage with the intraoral tracers was the difficulty in obtaining the records.

Finally, the results showed that the tracers and checkbite values were not different in a statistically significant level. This leads us to another query, whether all the time and effort of the dentist and patient spent on the elaborate steps involved in the tracing procedures was worthwhile. The findings of the study clearly show that the checkbites can be used as an accurate clinical procedure. But the verificatory status of the tracing methods cannot be ruled out. Tracing methods are also relevant to the profession; the choice is within the purview of the operator who develops a liking to a particular method. It is to be considered that checkbites exert more pressure on the soft tissue

when compared to the tracers. Tracers will be able to provide a definite advantage to 'realeff' in providing a smooth glide from the first contact to maximum intercuspation. This facility will be totally nullified when check bites are used.

The sample size used in this study did not allow a comparison of factors like age and sex of the individuals.

The conclusions drawn from the study are as follows.

1. The articulator value of horizontal condylar angle was higher than cephalometric value in majority of the subjects in all the five experimental methods.
2. There was no statistical difference between the cephalometric and articulator values in all the five experimental methods.
3. There was no significant difference between hight tracer, Chandra tracer, intraoral tracer, functiograph and checkbite methods.
4. Ranking the experimental methods in the order of efficiency: the first was the intraoral tracer, second being functiograph followed by Chandra tracer, checkbite and hight tracer.
5. Checkbite alone can be used to set the horizontal angles on the articulator in edentulous subjects.
6. Tracings can be used as a verificatory method.
7. Centric relation position was found to be the same in a subject with all the experimental methods.
8. Each experimental method can influence the condylar path differently in the eccentric movements.

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