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RESEARCH ARTICLE

A COMPARATIVE CLINICO-RADIOGRAPHIC ANALYSIS OF HORIZONTAL CONDYLAR GUIDANCE DETERMINED BY HIGHT TRACER, NOVEL INDIGENOUS INTRAORAL DIGITRACER AND CHECKBITE IN COMPLETE DENTURE PROSTHESIS

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ABSTRACT

Purpose of study: All graphic tracings are not necessarily accurate due to difference in skill of dentist, cooperation of patient, complexity of device, relative reliability and ease of recording. An indigenous Digitracer which is smaller and lighter, is provided with personal computer and the sensor portion to serve as a miniature lightweight tracing board connected to the digitizer control circuit set in an extraoral location which gives real values in real time. This clinical study was oriented towards comparing different horizontal condylar guidance registration methods, an traditional Extraoral Hight Gothic arch tracer, a Novel Indigenous Intraoral Digitracer and Checkbite in reproducing HCG on semi-adjustable articulator and critically analyse if any discrepancy would occur in the condylar guidance values when compared on standard cephalometric readings.

Materials and Methods: In this study 10 subjects were randomly selected in age group 40-60 years with upper and lower well-formed edentulous arches. All the steps for fabrication of denture till jaw relation were carried out. The centric and protrusive plaster check records were obtained with the three methods. For each patient following readings were recorded.

- Horizontal Condylar guidance measured on Hanau wide vue articulator.
- Cephalometric horizontal condylar guidance.

All data was statistically analysed.

Results:

- No statistical difference between the cephalometric and articulator values in all the three experimental methods.
- No significant difference between among all three methods.

Conclusion: The Digitracer is as efficient as other methods in determining the horizontal condylar guidance. Horizontal condylar guidance obtained by Digitracer is as accurate as obtained by standard Lateral Cephalogram.

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INTRODUCTION

Centric and eccentric relations of mandible can be recorded through checkbites, graphic recordings (innovative digitracer), functional recordings and cephalometrics. These records are then transferred to a semiadjustable articulator so that it can be set to simulate the human system. This study is an attempt to compare the accuracy of the checkbite and graphic recordings using cephalometrics as a standard. (Nandini *et al.,* 2005) An novel and indigenous digital gothic measuring system is developed with resistive technology mechanism named as digital gothic arch tracer. The system with personal computer is set by sensor portion of digitizer into the oral cavity. This serves as a miniature light weight tracing board and is connected with a digitizer control circuit set in an extraoral location. This integration of digital technology allows each mandibular position to be displayed in a distinguishable manner on a computer display in real time while being recorded and analysed. (Yoshiyuki Watanabe, 1999) This novel digitracer is smaller and lighter in weight and hence doesnot reduce the stability of the occlusal plate or impede physiological mandibular movement during jaw position recording. As compared to the known intraoral and extraoral gothic arch tracing techniques, this system developed allows measurement by intraoral method, and is smaller and lighter, while permitting the movement path to be traced and the horizontal mandibular position to be viewed on a display. A comparision between different horizontal condylar guidance registration method and indigenous digitracer alongwith conventional checkbite and traditional height tracer in

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reproducing horizontal condylar guidance angle is the aim of this clinical study. Horizontal condylar guidance angle on semiadjustable articulator and analysis of condylar guidance value are compared clinicoradiographically with jaw position recording and standard cephalometric readings.

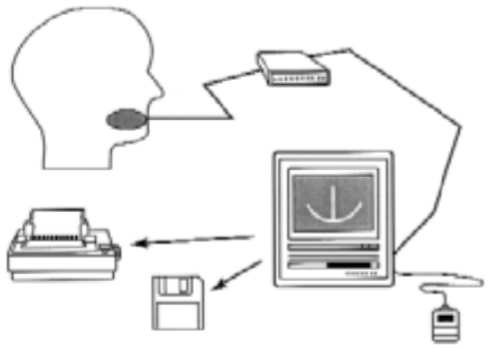


Figure 1. Digital gothic arch tracing system

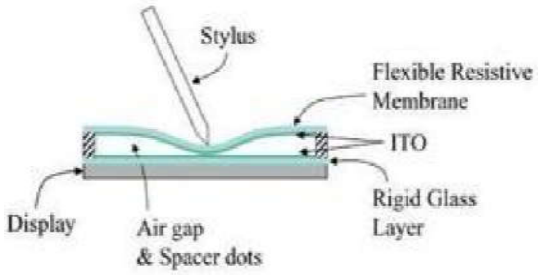


Figure 2. Resistive technology mechanism

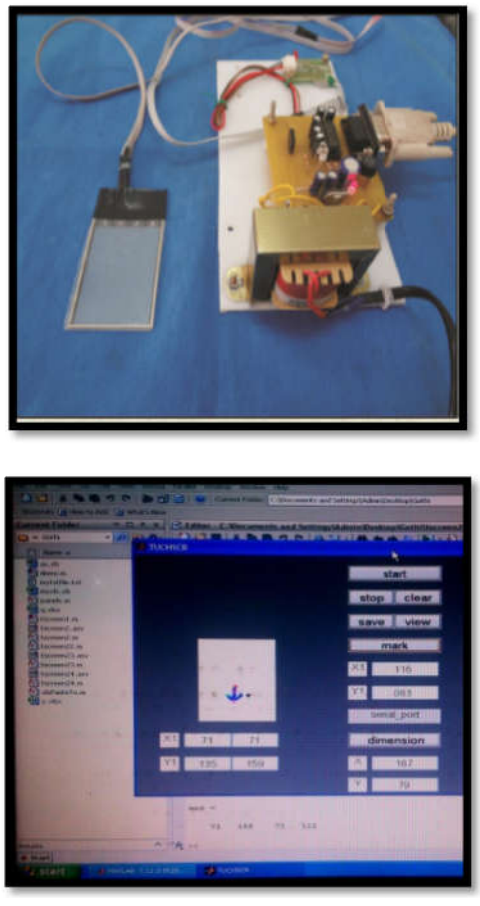


Figure 3. System circuit of novel indigenous intraoral digitracer

MATERIALS AND METHODS

Ten subjects were randomly selected in age group 40-65 years with upper and lower well-formed edentulous arches. Subjects with temporomandibular disorders, neuromuscular disorders were excluded. Every patient gone through a complete intra oral and extra oral examination. Impressions were prepared using conventional techniques and master casts were prepared using dental stone. Permanent record bases were fabricated. Occlusal rims were prepared and adjusted in the patient's mouth to register the maxilla-mandibular relations. Using facebow transfer the maxillary cast was mounted on Hanau wide vue articulator. Tentative centric relation was recorded at the conventionally established vertical dimension. Mandibular cast was mounted with the help of tentative registration. The objective of the study required verification of the centric relation using three registration method's 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. First, the experiment was completed with one registration method and then the occlusion rim was fabricated again using the putty index, and the second registration method was carried out. Three pairs of occlusal wax rims were fabricated and horizontal condylar guidance was determined by the hights tracer (GROUP B), indigenous digitracer (GROUP C) and checkbite method (GROUP D) and compared with the condylar guidance obtained by gold standard lateral cephalogram (GROUP A) as follows :

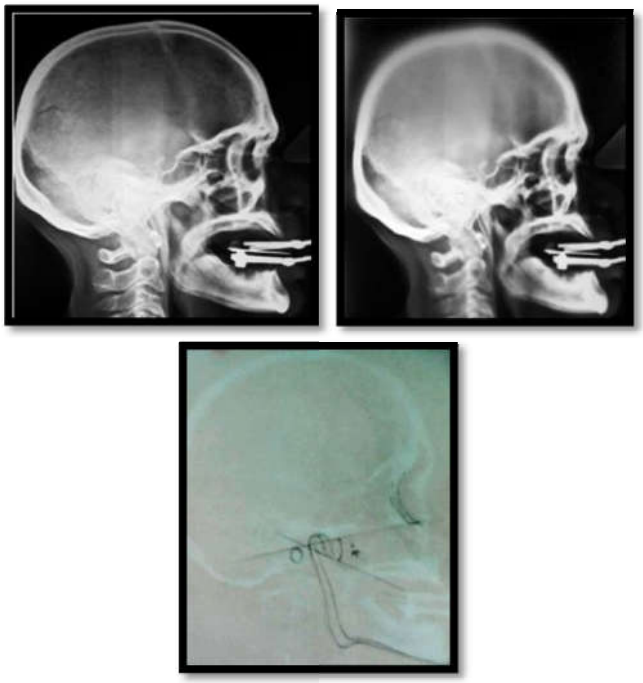


Figure 4. Condylar guidance determination by lateral cephalogram

GROUP A (Lateral cephalogram with Hights Tracer as gold standard)

Patient was trained to carry out centric and eccentric mandibular movements with the Hights tracer attached to one

pair of occlusal wax rims. Two lateral cephalograms were taken in two positions of same side as follows with standard technique:

1) In centric position
2) In protrusive relation (6mm)

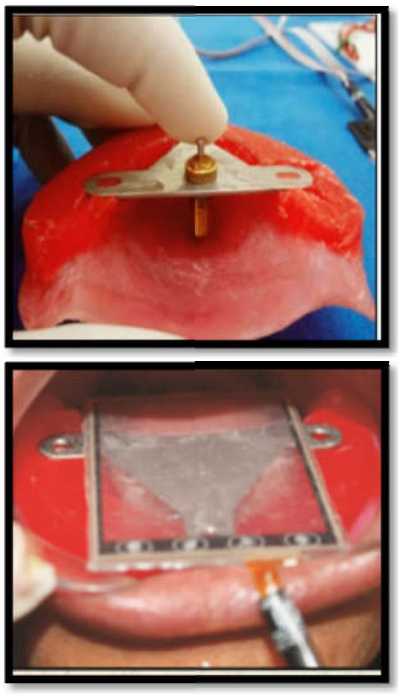
Cephalometric tracings were done. Tracings were made on the lateral cephalogram for Frankfort horizontal plane from orbitale to porion. The posterior and superior most point on the condyle, condylion, was traced onto a tracing film from the centric relation cephalogram. The protrusive relation cephalogram 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 guidance and was recorded which was used as a standard with the value read on the articulator with the other three groups (GROUP B,C,D). (Figure 4)

GROUP B (Extraoral Hight tracer): The Extraoral Hight Tracer 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 forward and is attached to the lower rim . 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 black sooth 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 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. 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) The result of horizontal condylar guidance thus obtained on articulator are compared with the results of horizontal condylar guidance with lateral cephalogram (GROUP A) (Figure 5)

GROUP C(Novel indigenous Intraoral Digitracer)

A specially customized intraoral digital tracing device was made for purpose of the study. The system in principle consisted of 3 parts namely intra-oral sensor portion of digitizer, extraoral digitizer circuit and a computer display having an analysis software programme. The system takes help of personal computer and by setting the sensor portion of a digitizer into the oral cavity to serve as a miniature lightweight tracing board and by connecting this with a digitizer control circuit set in an extraoral location allows each mandibular position to be displayed in a distinguishable manner on a computer display in real time, while being recorded and analysed. The intra-oral sensor was made up of a touch pad working on a resistive technology. Computer‟s/Laptop‟s port reads X & Y dimension and Matlab®; a computing analysis software programme shows the exact location of Stylus pin Changes in Y co-ordinates represented movement in antero-posterior direction while changes in X co-ordinates were associated with lateral movement over the tracing board. Central bearing device for maxillary occlusal rim essentially consisted of a spring loaded stylus in middle of the device. Stylus was spring loaded so as to maintain contact with the mandibular touch pad all the while during protrusive movement. The result of horizontal condylar guidance thus obtained on articulator are compared with the results of horizontal condylar guidance with lateral cephalogram (GROUP A) (Figure 6)

Figure 5. Gothic arch tracing with extraoral hights tracer



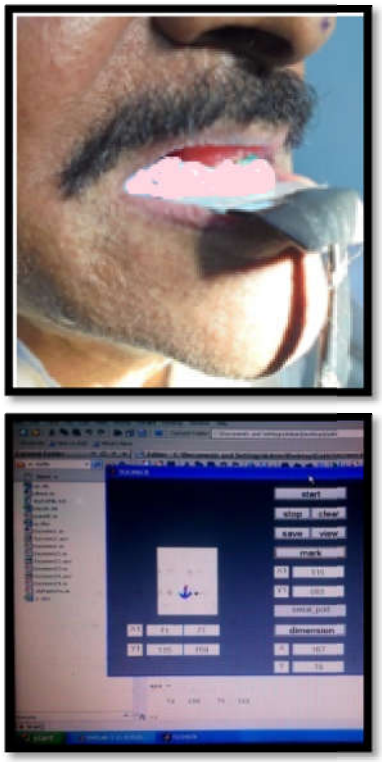


Figure 6. Gothic arch tracing with Digitracer

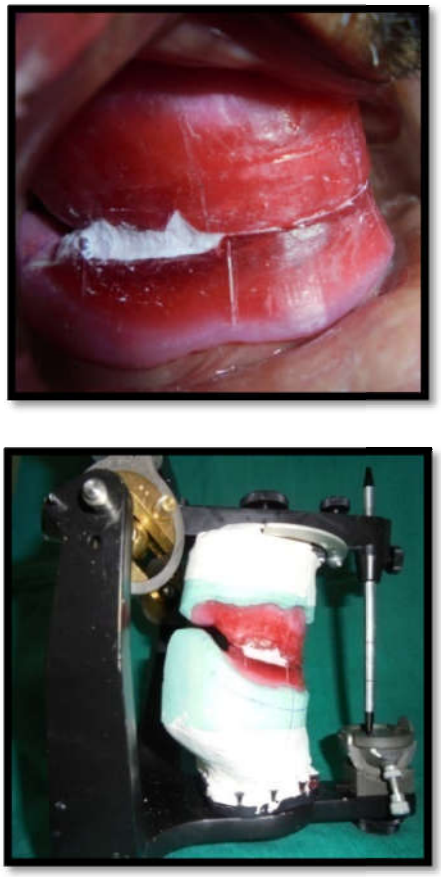


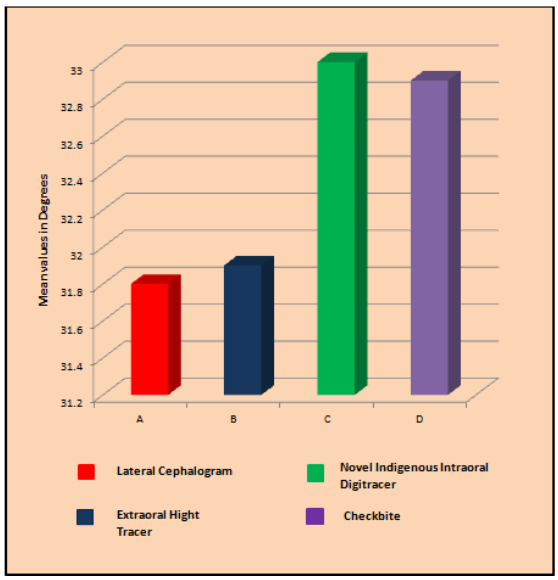
Figure 7. Direct interocclusal checkbite

GROUP D (Checkbite method)

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. Impression plaster 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. 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. The result of horizontal condylar guidance thus obtained on articulator are compared with the results of horizontal condylar guidance with lateral cephalogram (GROUP A) (Figure 7)

The resultant horizontal condylar guidance readings thus obtained by GROUP A,B,C,D were recorded and statistically analysed. Based on these readings four groups were formed, GROUP A (Lateral cephalogram), GROUP B (Hights tracer), GROUP C(Novel indigenous Digitracer) and GROUP D (Checkbite). Values obtained from all the three methods were the angles measured in degrees which were tabulated. (Table 1)

Post-hoc comparison was done of mean scores between gold standard & other three experimental groups (GROUP A with GROUP B,C,D) by Tukey's Test. P value obtained 0.81that means there was no significant difference in mean horizontal condylar angle obtained with all experimental methods ($p>0.05$). (Table 2) Pearson correlation coefficient(r) between GROUP A and GROUP B obtained 0.71 and p value obtained 0.02. Pearson correlation coefficient(r) between GROUP A and GROUP C is 0.78and p value obtained 0.008 .Pearson correlation coefficient(r) between GROUP A and GROUP D is 0.70 and p value obtained 0.02 (Table 3, Graph 1) Correlation of GROUP B with GROUP A ($r=0.71$) was high & also it was found to be significant ($p<0.05$). Similarly, correlation of GROUP D with GROUP A ($r=0.70$) was high & also it was found to be significant ($p<0.05$). But, horizontal condylar angle obtained with GROUP C was significantly & highly correlated with GROUP A ($p<0.05$). Also, correlation coefficient of GROUP C ($r=0.78$) with GROUP A was higher than correlation of GROUP B ($r=0.71$) &GROUP D ($r=0.70$) with GROUP A. Thus, GROUP C is most efficient & accurate amongst all the other three methods. (Table 3,Graph 1)



Graph 1. Comparison of horizontal condylar guidance (in degrees) obtained by different experimental methods

Table 1. Horizontal Condylar Guidance (in degrees) obtained by different experimental method

Sr. No.	Lateral Cephalogram (gold standard) (A)	Extraoral Hight Tracer (B)	Novel Indigenous Intraoral Digitracer (C)	Checkbite (D)
1	28	28	29	30
2	34	36	37	36
3	33	30	32	31
4	31	30	29	33
5	33	30	34	32
6	31	32	34	33
7	34	35	36	35
8	30	31	32	32
9	31	32	30	33
10	33	35	37	34

Table 2. Comparison of mean scores of horizontal condylar guidance (in degrees) of different experimental methods with the gold standard

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		P* Value	Post-hoc# test
					Lower Bound	Upper Bound		
Lateral cephalogram (A)	10	31.8000	1.93218	.61101	30.4178	33.1822		
Extraoral Hight Tracer(B)	10	31.9000	2.64365	.83600	30.0088	33.7912	0.56	A=B=C=D
Novel Indigenous Intraoral Digitracer(C)	10	33.0000	3.09121	.97753	30.7887	35.2113		
Checkbite(D)	10	32.9000	1.79196	.56667	31.6181	34.1819		
Total	40	32.4000	2.39444	.37859	31.6342	33.1658		

Table 3. Correlation of horizontal condylar angles (in degrees) obtained by gold standard lateral cephalogram & other experimental methods: Pearson correlation

	Lateral cephalogram(A)	P* value
Extraoral Hight Tracer(B)	0.71	0.02
Digitracer(C)	0.78	0.008
Checkbite(D)	0.70	0.02

DISCUSSION

The most essential consideration in prosthetic rehabilitation of complete denture patient is the inclination of condylar path, to develop occlusion in harmony with stomatognathic system. (Prasad *et al.,* 2012) Condylar guidance is described as the mandibular guidance generated by the condyle and articular disc traversing the contour of the glenoid fossae or, synonymously, as the mechanical form located in the upper posterior region of an articulator that controls movement of the mobile member. (Glossary of prosthodontic terms, 2005) Condylar guidance inclination plays a very crucial role in restoring the occlusion of the patient. Condylar guidance inclination need to be recorded accurately for individual patients and precise transfer of the records on an articulator is also mandatory to imitate the protrusive and lateral excursive movements on the semi adjustable articulator in a manner similar to that of patient. (Weinberg, 1959) Though various condylar guidance determination methods available but due to deprivation of simple, practical method for quantitatively evaluating the condylar guidance has lead to motivation for integration of digital technology in prosthodontics. This study aims to compare the accuracy of the checkbite and graphic recordings (Hights tracer and indigenous digitracer) using cephalometrics as a standard. An indigenous Digi tracer was designed to make tracing a simpler procedure in general overcoming the drawback of conventional methods in particular such as attachment of the Extraoral Hight Tracer which is a tedious procedure and also tracing could not be stored for future references which leads to another appointment. Here, sensor plate and personal computer were used for tracings and hence the tracings could be stored with software (Matlab®). The other advantage was that the time is saved in 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 to obtain the records is overcome with the personal computer which can save the tracing and gives reading in co-ordinate system on display so that patient can visualise and reproduce the same movement and maintain the record for future reference. Variations have been found in recording the articular inclinations between different materials and/or different methods of transferring it to the semi adjustable articulator. (Gross *et al.,* 1998; Gross *et al.,* 1990; Aull, 1965) Semiadjustable articulators are used to relate the maxilla with the mandible and to simulate functional movements. For this, the semiadjustable 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. (Nandini *et al.,* 2005) Condylar guidance can also be recorded with radiographs, lateral cephalometrics, pantomograph, tomography, digital CT scans and electronic axiography. (Hue, 2011) The use of average condylar inclination for every patient is not advisable. (Posselt and Nevstedt, 1961) With all the advantages of the digital intraoral digitracer, it is analysis related to the comparision of the condylar guidance determined by tracers (Hights tracer and innovative digitracer) and cephalometrics as a standard.

Thus this study is with an aim to compare different horizontal condylar guidance registration method;indigenous digitracer alongwith conventional checkbite and traditional height tracer in reproducing horizontal condylar guidance angle. The horizontal angles obtained using cephalometrics were lesser than those on the articulator, which means that the anatomical values are actually lesser (Table 1). V.V.Nandini, K.C.Nair, M.C.Sudhakar, T.S.Poduval (2005) and Boos. (Boos, 1951)

The difference in horizontal angle observed in cephalograms and other methods for the same individual can be due to the influence of anterior guidance and condylar guidance being taken as the measuring parameter. The temporomandibular Lateral cephalogram indicates the actual form and angles of the osseous structures of the joint but the functional registration indicate the condylar path angles as they might be because of the resultant jaw relation. The Different methods experimented influenced the condylar path independently. Finally, according to the One way ANOVA test the cephalogram, tracers and checkbite values were not different in a statistically significant level as Mean of values obtained from GROUP A - 31.8, GROUP B -31.9, GROUP C -33 and GROUP D-32.9 and Standard deviation obtained from GROUP A -1.93218 GROUP B -2.64365, GROUP C -3.09121 and GROUP D-1.79196. According to Post hoc comparision among the experimental groups P value obtained 0.81($p>0.05$). By conventional criteria, this difference is considered to be statistically insignificant. (Table 2) This suggest that all the four methods GROUP A(Lateral Cephalogram), GROUP B(Hights tracer), GROUP C(Digitracer) and GROUP D(Checkbite) are comparable to each other in measuring condylar determinant. These results were supported by the results obtained by Nandhini in 2005 on compairing horizontal condylar guidance determined by various intraoral, extraoral tracing and cephalometric methods. While correlating the efficiency of other three experimental method with the cephalometric method, the Pearson correlation coefficient(r) between GROUP A and GROUP B obtained 0.71 and p value obtained 0.02. Pearson correlation coefficient(r) between GROUP A and GROUP D is 0.70 and p value obtained 0.02 (Table 3, Graph 1). P value is statistically significant in both the comparision ($p<0.05$). This concedes that GROUP B (Hights tracer) is more reliable than GROUP D(Checkbite) in determining horizontal condylar guidance. Hence these results were supported by the results of the study conducted by Zamaconna *et al*. (1992) in 1992 and Kapur and Yurkstas (1957) comparing the duplicability of centric records obtained using extraoral tracing, intraoral tracing and wax registrations. It was found that all the methods were consistent. Wax registration method was found to be the least reliable and Graphic method make it possible to obtain accurate measurements of condylar guidance. But, horizontal condylar angle obtained with GROUP C was significantly & highly correlated with GROUP A with Pearson correlation coefficient (r) 0.78 and p value obtained 0.008 ($p<0.05$) (Table 3, Graph 1). The GROUP C (indigenous digitracer) shows strong association to the GROUP A(Lateral Cephalogram) as compared to GROUP B(Hight tracer) and GROUP D(Checkbite). This concedes that indigenous digitracer reproduce nearly same natural anatomic condylar guidance as that is reproduced in standard lateral cephalogram.

The 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. 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. With the above understanding and within the limitation of this study, further more studies with increased sample size should be conducted to throw light on the precision and accuracy of innovative digitracer with various advantages namely simple, smaller, lighter, feasible, time saving and economical. Within the limited sample size and statistical analysis test performed, it is concluded that though the horizontal condylar guidance determined by Hight Tracer, indigenous digitracer and checkbite was found to be statistically insignificant, the condylar guidance determined by digitracer is highly correlated with the lateral cephalogram. A simple indigenous digitracer is one of its kind and the most convenient method which suits the particular clinical situation by serving the purpose of providing maximum efficiency and accuracy in determining condylar guidance among all the methods.

Conclusion

Within the limitation of the study, from the results obtained from the study following conclusions may be drawn:

- There was no statistical difference between the cephalometric and articulator values in all the four experimental methods.
- There was no significant difference between Extraoral Hight Tracer, Novel indigenous Intraoral digitracer and Checkbite methods
- Ranking the experimental methods in the order of efficiency: the first is the novel indigenous Intraoral digitracer, second being followed by Extraoral Hight Tracer and Checkbite.

Thus, a digital technology based Novel Indigenous Intraoral Digitracer which is simple, convenient and economical can be used to measure the Horizontal Condylar Guidance in patients with precision and accuracy.

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