



RESEARCH ARTICLE

AN ALTERNATIVE METHOD TO DETERMINE THE SAGITTAL CONDYLAR GUIDANCE IN EDENTULOUS PATIENTS

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ABSTRACT

Condylar guidance on articulators is an approximate duplication of the condylar path in patients and reproduced on the instrument with the help of interocclusal records (Zarb *et al.*, 2004). Varying inclinations have been reported with consecutive registrations, between operators, between recording materials, and between articulators (Christensen, 1978; Gysi, 1929). The purpose of this study is to compare condylar guidance values obtained from arcon and non-arcon articulators with the gold standard values of cephalometric readings and to analyze which articulator gives more accurate readings. And also to check whether lateral cephalogram can be used to determine the condylar guidance value of the patient. This will save the valuable clinical time in adjusting the occlusion.

INTRODUCTION

Success of complex prosthodontic procedure is enhanced by accurate simulation of the condylar path of patient on an articulator (Goyal, 2011). The main aim of Prosthodontic rehabilitation is to make a prosthesis, which is in harmony with the patient's stomatognathic system. The inclination of the condylar path is the most important consideration in the oral rehabilitation (Rupal, 2013). Analogue of condylar guidance on an articulator is considered to be necessary requisite in prosthodontics (Posselt, 1968). Moreover, in the fabrication of complete removable dentures the sagittal condylar guidance is believed to play a crucial role for the setting of artificial teeth (Mohl *et al.*, 1988). 'The inclination of the condylar guidance does not change and once it is registered should be accepted' (Van Reenen & Thomas) (Christensen, 1978). Sagittal condylar inclination was highly variable, but this variability does not seem to be attributed to condylar asymmetry, gender, or age of the adult patients (Preti *et al.*, 1982). Semi-adjustable articulators are commonly used in restorative dentistry, especially in prosthodontics for their simplicity in handling and programming.

So, this study was aimed to compare condylar guidance obtained from radiographic method, with the values obtained from arcon and non arcon articulators by conventional gothic arch tracing method.

Aims and Objectives

The aim of this study was to compare evaluation of sagittal condylar guidance of arcon and non-arcon articulators with cephalometric tracing readings.

The main objectives of this study are

- To analyze whether Arcon or Non Arcon Articulator gives closer readings to cephalometric tracing readings.
- To analyze if it is permissible to use cephalometric readings for determining sagittal condylar guidance .

MATERIALS AND METHODS

The purpose of this study is to compare condylar guidance values obtained from arcon and non-arcon articulators with the gold standard values of cephalometric readings and to analyze which articulator gives more accurate readings. Following materials, equipments and instruments were used in this study: Materials used in this study were.

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MATERIAL NAME

Dental Plaster, Dental stone, Impression compound, Green stick impression compound, Zinc oxide impression paste, Modelling wax.

Equipments used in this study were

- Cephalostat radiograph machine [ADVAPEX] (Colour plate 3 Figure. 5)

Instruments used in this study were

- Arcon articulator (Hanau Wide Vue) (Colour plate 2; Figure3)
- Facebow (Hanau springbow, Waterpik, Fort Collin, USA) (Colour plate 2; Figure 4)
- Non Arcon articulator (Dentatus) (Colour plate 1; Figure 1)
- Facebow (Facia type) (Colour plate 1; Figure 2)
- Vibrator
- Rubber bowl
- Mixing spatula

After preparing the record bases and interocclusal wax rim, orientation jaw relation was taken with the help of face bows of both the articulators as per the standard technique. (colour plate 4; Figure 6,7) and transferred onto the hanau and dentatus articulator by direct mounting technique followed by tentative jaw relation. Central bearing device were attached and Gothic arch tracings were done. Then similarly plaster records were made at centric and protrusive relation (6mm). (colour plate 5; Figure 8). Then the protrusive plaster check-record was inserted between the rims and then the articulator was programmed for condylar guidance value. (colour plate 5; Figure 9,10).

The resultant readings were recorded. Per patient three readings were recorded. And they were as follows:

- Condylar guidance measured on arcon articulator.
- Condylar guidance measured on non-arcon articulator.
- Cephalometric sagittal condylar guidance

Two lateral cephalograms were taken in two positions of same side as follows:

- In centric position
- In protrusive relation (6mm)

TRACING PROCEDURE

Tracings were made on the lateral cephalogram for Frankfort horizontal plane from orbitale to porion. Two most posterior points are marked on articular eminence were marked and a line is drawn through them. Angle of bisecting these two reference lines is interpreted and is considered as cephalometric sagittal condylar guidance value (colour plate 6; Figure 11, 12)

The values for condylar guidance were divided into three groups:

Group I: Values obtained from Arcon articulator

Group II: Values obtained from Non Arcon articulator

Group III: Values obtained from Radiographic method

RESULTS

Values obtained from all the three methods were the angles measured in degrees which were tabulated.

One way ANOVA test was used for overall comparison of mean condylar guidance angle between gold standard & both the experimental groups. Mean of values obtained from GROUP 3 is 43° , GROUP 1 is 40.5° and GROUP 2 is 36.2° . Standard deviation, based on this test, between Group I and Group II is of 4.03° and 4.36° and P Value equals 0.01. By conventional criteria, this difference is considered to be statistically significant. (Table 2; Graph 1)

Table No. 1. Comparison of mean sagittal condylar guidance values of experimental groups with the lateral cephalometric readings

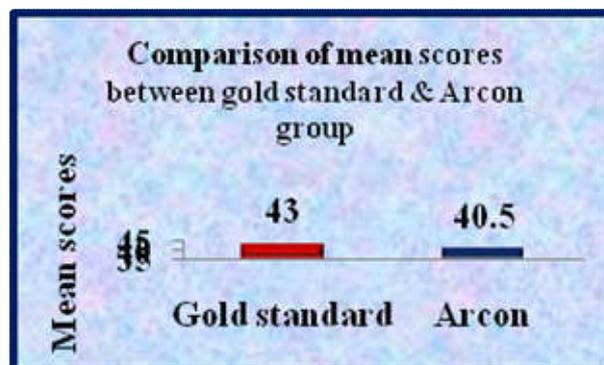
Group	Mean (SD)	P* Value	Significant
Lateral Cephalogram	43(5.81)		
Arcon	40.5(4.03)	0.01	Yes
Non-arcon	36.2(4.36)		

* - One way ANOVA test

Table No. 2. Post-hoc comparison of mean scores between gold standard & experimental groups

Test details	Mean 1	Mean 2	Mean difference	P* value	Significant?
Lateral Cephalogram vs Arcon	43	40.5	2.5	0.48	No
Lateral Cephalogram vs Non-arcon	43	36.2	6.8	0.01	Yes
Arcon vs Non-arcon	40.5	36.2	4.3	0.01	Yes

*- Tukey's test



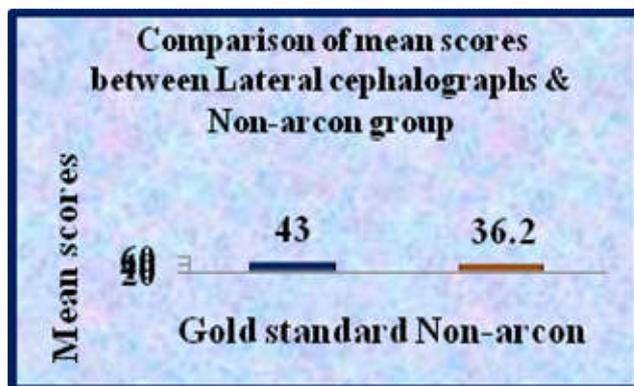
Graph 1.

Post-hoc comparison was done of mean scores between gold standard & experimental groups [GROUP 1 & GROUP 2] by Tukey's Test. Mean difference between GROUP 3 and GROUP 1 [Arcon] is 2.5° and P value is 0.48 i.e. Greater than 0.01, that means non significant difference found in values of cephalogram and arcon articulator. (Table 3; Graph 2)

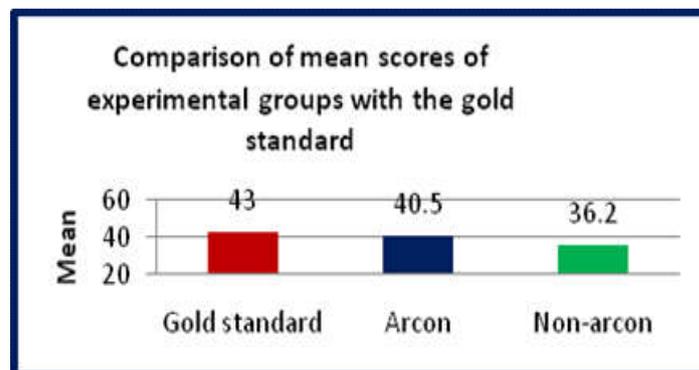
Table No. 3. Reliability of Arcon & Non- arcon articulators in estimating the scores

GROUPS	ICC	95% CI	P* Value
Lateral Cephalographs vs Arcon	0.92	0.71 – 0.98	< 0.001
Lateral Cephalographs vs Non-arcon	0.95	0.82 – 0.98	< 0.001
Arcon vs Non-arcon	0.95	0.81 – 0.98	< 0.001

*- ICC – Intraclass correlation coefficient



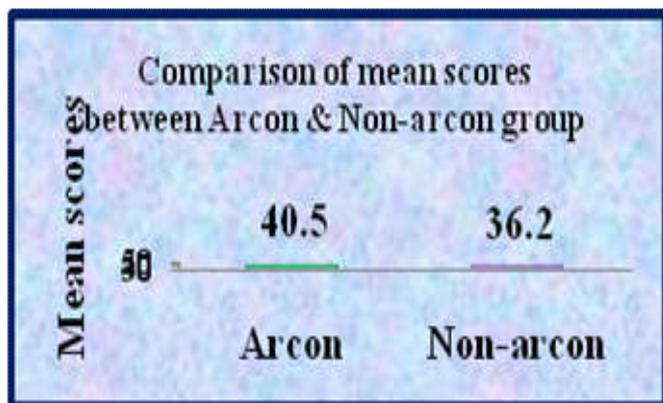
Graph 2.



Graph 4.

The mean difference between GROUP 3 and Group 2 [Non arcon] is 6.8° and P value is 0.01 that means significant difference was found in values of cephalogram and non arcon articulator. The mean difference between GROUP 1 & GROUP 2 is 4.3° and P Values were found to be 0.01 that means significant difference was found between values of arcon and non arcon articulator. ($P < 0.01$)

Intraclass correlation coefficient (ICC) between GROUP 3 and GROUP 1 is 0.92 in 95 % confident interval 0.71-0.98. ICC between GROUP 3 and GROUP 2 is 0.95 in 95% confident interval 0.82-0.98. ICC between GROUP 1 and GROUP 2 is 0.95 in 95% confident interval 0.81 -0.98. $P < 0.01$ so, results were found to be significant (Table 4; Graph 3)



Graph 3.

Comparison of sagittal condylar guidance values of lateral cephalometric tracings, arcon and non arcon articulators in degrees

PATIENT NO.	GOLD	ARCON	NON ARCON
1	34	36	30
2	46	45	38
3	42	40	34
4	38	35	30
5	34	35	32
6	48	45	40
7	50	45	42
8	45	40	38
9	48	42	40
10	45	42	38

DISCUSSION

Condylar guidance inclinations need to be recorded accurately for individual patients and precise transfer of this 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.

This will save the valuable clinical time in adjusting the occlusion. Condylar guidance can also be recorded with radiographs, lateral cephalometrics, pantomograph, tomography, digital CT scans and electronic axiography. There are various articulator systems to record sagittal condylar guidance which vary in reproducing sagittal condylar guidance angulations. Studies for recording condylar inclination on various articulator systems in edentulous patients are very scarce. In this study two articulators have been used; one is Arcon (Hanau™ Wide-View Articulator, Whip Mix Corporation, USA) and another is Non-Arcon (Dentatus) Boos *et al.* in 1951 stated that the temporomandibular x-ray film indicates the actual form and angles of the osseous structure of the joint. Various studies have shown that protrusive condylar guidance angles obtained by panoramic radiograph may be used in programming semi-adjustable articulators (Posselt, 1968). Variations have been found in recording the articular inclinations between different materials and/or transferring it to the semi adjustable articulator. Zamacona in 1992 has stated that the graphic method makes it possible to obtain accurate measurements of the condylar inclinations of each side.

Some authors have recommended this method for determining the condylar path inclination in edentulous patients (Gross, 1998; Gross, 1990; Aull, 1965; Dawson, 1989). Studies by Zammacona and some other authors found variations in condylar guidance angles ranging from 5° to 55° and that there is insignificant variation between left and right condylar guidance. So, we considered the mean values for the study (Lundeen, 1973; Preti *et al.*, 1982; Dawson, 1989). Various methods used to record condylar guidance angle clinically have been often reported to exhibit wide variations between each other, so this present study was done to develop a clinical method which will be simple, economical as well as significant. Use of lateral cephalogram to clinically find the sagittal condylar guidance values which could possibly eliminate the need of taking interocclusal check records, is the direction of focus of this study. The semiadjustable articulators used were Dentatus (nonarcon type) and Hanau wide-view (arcon type) with their respective face-bows. Particular articulator systems were used because both of them make use of the orbitale as the anterior point of reference for orientation of the maxillary cast which standardizes the three-plane position of the maxillary cast on both the articulators. Thus, the influence of the error induced by face-bow registration could be eliminated in this study. Semi-adjustable articulators are commonly used in restorative dentistry, especially in prosthodontics for their simplicity in handling and programming.



Figure 1 : Dentatus Articulator (NonArcon)



Figure 3: Hanau Wide Vue Articulator (Arcon)

COLOUR PLATE 1



Figure 5: Panoramic Radiograph Machine (ADVAPEX)



Figure 2: Fascia Type Facebow



Figure 4: Ear piece Type facebow



Figure 6: Orientation relation using fascia type facebow

COLOUR PLATE 2



Figure 7: Orientation relation using ear piece type facebow



Figure 9: Programming of Dentatus Articulator



Figure 8: Gothic arch tracing



Figure 10: Programming of Hanau Wide Vue Articulator

COLOUR PLATE 3



Figure 11: Lateral Cephalogram

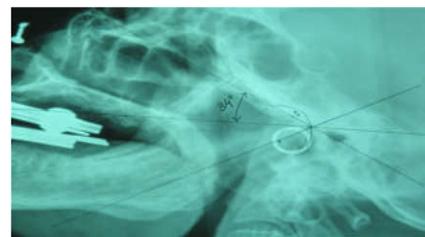


Figure 12: Tracing of Lateral Cephalogram

The condylar axis may be either arbitrary (Bergstrom's point and Beyron's point) or kinematic (true hinge axis). The lateral cephalometric radiographic measurements have been used by few authors to provide results that were representative of anatomic orientations (Christensen, 1978). An average anterior reference level on the incisal guide pin has been indicated with many articulators (Rosensteil *et al.*, 2006). In all the Hanau articulators, this is marked by means of a groove placed into the incisal guide pin (Rosensteil *et al.*, 2006). Mean value of GROUP 1 is 40.5° and mean value of GROUP 2 is 36.2°, so the mean difference of sagittal condylar guidance values is 4.3°.

P value is 0.01 that means the difference is significant with lesser values for GROUP 2 i.e. Non Arcon articulator readings. This difference might be due to the fact that condylar inclination changes in relation to maxillary occlusion in non-arcon articulators as a certain degree of opening of the articulator takes place, whereas in arcon articulators condylar inclination remains constant in relation to the maxillary occlusion plane at any degree of opening of the articulator. According to Rosensteil *et al.* with the non-arcon design condylar inclination of the mechanical fossae changes in relation to the maxillary occlusion plane as the articulator is opened and can lead to errors when a protrusive record of certain thickness is being used to program the articulator.

Post-hoc comparison was done of mean scores between gold standard & experimental groups by Tukey's Test. In this, mean value of GOLD and GROUP 1 is 43 and 40.5 so the mean difference between GOLD and GROUP 1 is 2.5. The P value is greater than 0.01. It means the difference is not significant and the value of cephalogram is greater than that of arcon articulator readings by a difference of 2.5⁰. These findings correlate with the findings of Weinberg *et al.* (Weinberg, 1959) who studied the condylar movements and confirmed that in protrusion, the condylar head follows closely the anatomical form of the articular eminence and represents a very high correlation coefficient and level of significance. Gilboa *et al.* (Gilboa *et al.*, 2008) reported a high degree correlation between articular morphology and panoramic images and suggested that the inclination of the articular eminence in a panoramic image may condylar path is slightly less steep than the steepness of the articular eminence, which may be attributed to the active role played by the soft tissues during condylar movements.

The correlation between mean sagittal condylar readings of the arcon articulator and cephalometric readings could be possibly due to the anatomic representation of the articulator design in close approximation with the human temporomandibular joint. This anatomic simulation of the temporomandibular joint on the instrument may be responsible for near accurate replication of mandibular movements. However, a slight difference in values of both these groups could be justified by the active role played by the articular disc, ligaments, and muscles in condylar movements and neuromuscular synchronization during functional mandibular movements.

Summary and Conclusion

The aim of this in vivo study was to find correlation of sagittal condylar guidance of arcon and non-arcon articulators with cephalometric tracing readings. The angles obtained from cephalometric tracings method was taken as gold standard values. The angles of the Lateral cephalogram values were compared and correlated with the angles obtained from arcon and non arcon articulators by gothic arch tracings followed by interocclusal check record method of the same subject. From the results obtained from the study following conclusions may be drawn:

- The mean difference in sagittal condylar guidance obtained from Non Arcon (Dentatus) and Arcon (Hanau Wide Vue) articulators were highly significant indicating a low level of reproducibility.
- The mean difference in sagittal condylar guidance values obtained from Non Arcon (Dentatus) articulator and Lateral cephalometric tracings was statistically highly significant.
- Whereas, the mean difference in sagittal condylar guidance obtained from Arcon (Hanau wide vue) articulator and Lateral cephalometric tracings were non- significant.
- Sagittal condylar guidance recorded from the lateral cephalometric tracings were more closer to the natural or anatomic sagittal inclination than values obtained from arcon articulator and then non arcon articulator.
- Sagittal condylar guidance values of non arcon (Dentatus) articulator are found to be greater than those of arcon (Hanau wide vue) articulator.

- The readings of arcon (Hanau wide vue) Articulator are close to the readings of cephalometric tracings.

Thus, cephalometric tracings can be used to measure the sagittal condylar guidance in patients .

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