

A Study to Relate Sagittal Condylar Path and Horizontal Incisal Path with Bilateral Balanced Occlusion in Edentulous Subjects

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Abstract

Introduction Bilateral balanced occlusion is achieved when there is equilibrium on both sides of the prosthesis, due to the simultaneous contact of the artificial teeth in centric and eccentric occlusion. One of the areas in which research is lacking is the relation between sagittal condylar path (CP) and horizontal incisal path (IP) with optimal balanced occlusion.

Materials and Methods Semiadjustable Articulator Artex Arcon AP with Rotofix face-bow, 40 µ Bosch articulating paper of red and blue color, protractor, centric and protrusive interocclusal plaster records were used for the study on 50 completely edentulous subjects. Teeth arrangement was done with optimal balanced occlusion, and the numbers of contacts were recorded in centric relation and eccentric positions. Statistical analysis was done by using student's *t* test and Karl Pearson coefficient correlation.

Results The average sagittal CP was 30.38° in the age group of 40 to 55 years and 32.58° in the age group of 56 to 70 years, and the average horizontal IP was 15.79° in the age group of 40 to 55 years and 16.04° in the age group of 56 to 70 years. Statistically significant results were found between sagittal CP, horizontal IP with bilateral balanced occlusion in the age group of 40–55 years.

Conclusion Statistically significant relations were found in balanced occlusion between waxed up denture on articulator, processed denture on articulator and processed denture on articulator after selective grinding. Balanced occlusion is more predictable in a younger group of individuals.

Keywords

- sagittal condylar path
- horizontal incisal path
- bilateral balanced occlusion

Introduction

Oral rehabilitation of completely edentulous subjects requires fabrication of prosthesis which restores patient's functional and esthetical demands. For a complete denture prosthesis to be successful it should be made in harmony with the surrounding oral structures. State of balance or equilibrium is possible when forces acting on the prosthesis results in no motion. Achieving state of equilibrium or balancing should be of paramount importance when considering the forces

that act on the artificial teeth and the denture bases, thereby its resultant effect on the movement of the base. Bilateral balanced occlusion is achieved when there is equilibrium on both sides of the prosthesis due to the simultaneous contact of the artificial teeth in centric and eccentric occlusion. For the establishment of plane of equilibrium, a minimum of three contacts is required; with an increase in the number of contacts, the extent of equilibrium also increases.

During functional movements, the bases will shift, tip and torque on their foundation if occlusion of the denture

is not balanced bilaterally. During separation of teeth, it will become loose and can be unseated easily. This movement of denture bases is likely to abuse the foundation tissues and create soreness and inflammation, which may lead to accelerated bone resorption. A complete denture prosthesis fabricated with bilateral balanced contacts helps to seat the denture in a stable position during functional movements.

Bilateral balanced occlusion also holds greater importance during other activities like swallowing, bruxing activity, and during stress and closing movement to reseat the prosthesis. Patients provided with bilateral balanced denture do not upset the normal static, stable and retentive position of their dentures. Balanced occlusion provides the fundamental, mechanical feature that satisfies the requirements of recognized biologic and physiologic concepts for each individual patient.

Need for the Study

Sagittal condylar path (CP) (horizontal condylar inclination) and horizontal incisal path (IP) (lateral condylar inclination/lateral incisal guidance [IG]) of patients are the main factors in the establishment of occlusal balance for complete denture prosthesis.

One of the areas in which research is lacking and needs attention is the relation between sagittal CP and horizontal IP with optimal balanced occlusion. Also, it is necessary that the established balanced occlusion in the articulator should be improved or at least maintained in the patients' mouth at various interrelated transformation stages between clinical and laboratory procedures.

All said and done, the movement of the artificial teeth and consequent changes are inevitable and cannot be prevented but can be minimized with proper usage of recent materials and techniques. Hence, it is thought desirable to undertake this present study to relate sagittal CP (horizontal condylar inclination) and horizontal IP (lateral condylar inclination/lateral IG) with bilateral balanced occlusion during various clinical and laboratory procedures.

Aims and Objectives

This study aimed to (1) determine average sagittal CP, (2) determine average horizontal IP, (3) ascertain the possible relation between sagittal CP and horizontal IP with bilateral balanced occlusion, and (4) compare sagittal CP and horizontal IP between the age groups of 40 to 55 years and 56 to 70 years.

Source of Data

Fifty completely edentulous subjects visiting the Department of Prosthodontics.

Inclusion Criteria

- Completely edentulous subjects who are cognitively competent.

- Subjects with the age group of 40 to 70 years.
- Subjects with no generalized motor deficiencies.
- Subjects with adequate inter arch distance.

Exclusion Criteria

- Subjects with temporomandibular joint disorders.
- Subjects with poor neuromuscular coordination.
- Subjects with facial or skeletal malformations.

Materials and Methods (► Fig. 1)

Based on standard deviation (SD) of average sagittal condylar guidance (CG) of the two groups in the pilot study, 3.47 and 3.25, effect size of 0.80, alpha error of 5%, and power of 80, the sample size was calculated. For the purpose of the study a sample of 50, completely edentulous patients were taken randomly comprising both the genders with a mean age of 55 years. Preliminary data was collected after obtaining the patients' consent. Impressions were made by using standard techniques and jaw relation was recorded using Facebow transfer. Gothic arch tracing was recorded, and the angle was measured using a protractor. Sagittal condylar inclinations were recorded using extra-oral tracings, and the semiadjustable articulator (Arcon) was programmed using a protrusive interocclusal record.

Teeth arrangement was done with optimal balanced occlusion, and the number of contacts were checked in centric relation and eccentric positions (protrusive and lateral excursive movements) on the articulator and in the patient's mouth at the try-in stage using double-sided blue and red colored articulating paper (BAUSCH) of 40 microns in thickness. Following acrylization, the same procedure was followed with the processed dentures on the articulator before and after selective grinding as well as during the insertion of the prosthesis in the patient's mouth.

Blue articulating paper was used to mark the centric contacts by placing the paper on both the sides and tapping the articulator in centric position, and the number of contacts made was recorded on each tooth (► Fig. 2). The number of contacts was tabulated for the maxillary and mandibular arches. Then, the red articulating paper was used to mark the eccentric contacts. First, the red articulating paper was placed on both the sides; then, the articulator is closed in centric, and from this position it is moved to the right lateral position till the cusp tip of maxillary canine contacts with the cusp tip of mandibular canine on the same side. (► Fig. 3A, B). Now, blue articulating paper was used to mark the centric contacts, so as to differentiate it from the eccentric contacts and the numbers of contacts both on the working as well as on the balancing sides were recorded. The marks were wiped off and the same procedure was repeated to record the contacts in the left lateral position (► Fig. 3C, D) and protrusive positions with the respective movements (► Fig. 4A, B). The same procedure was used to record the various contacts during the different laboratory and clinical stages.

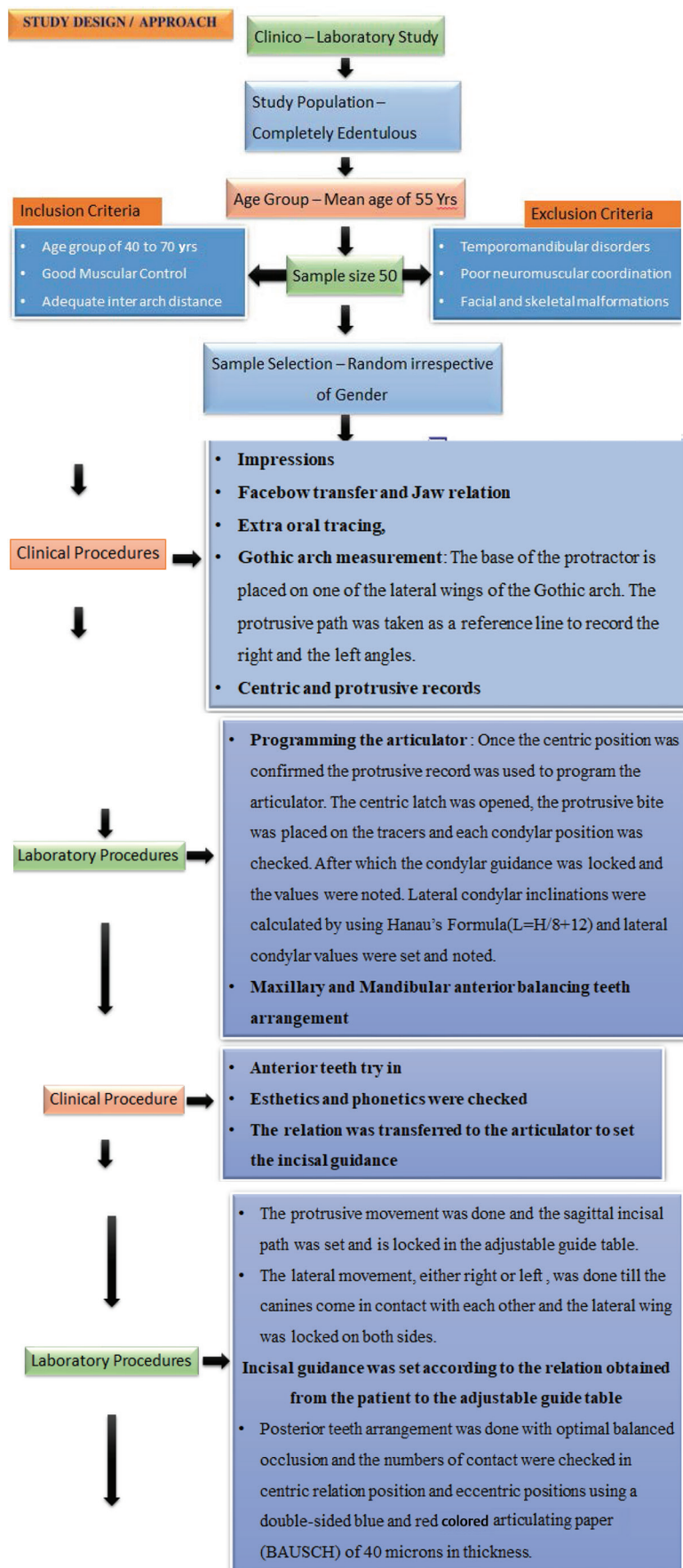


Fig. 1 Study design.

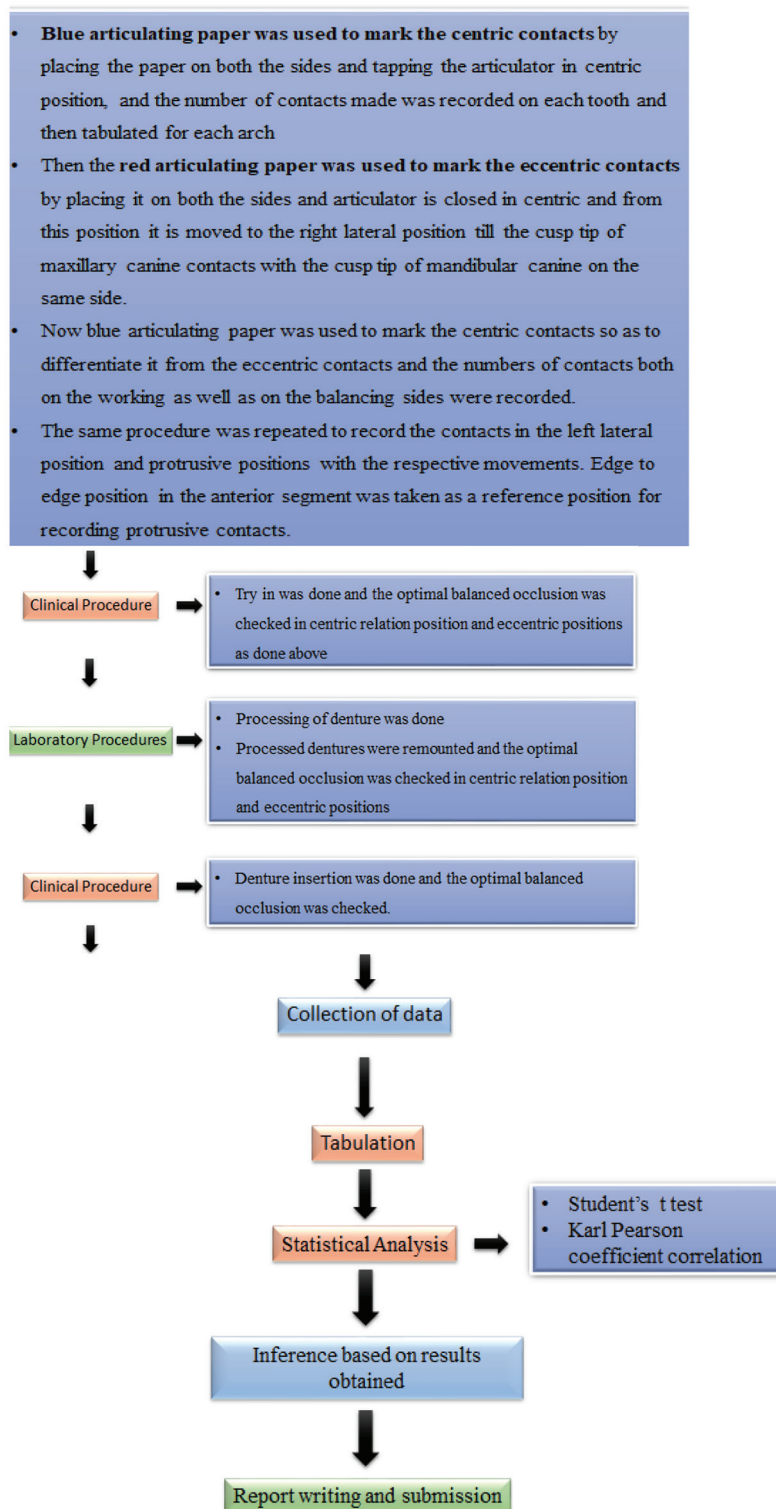


Fig. 1 (Continued) Study design.

Statistical analysis was done by using student's *t* test for comparison between groups, and the relationship was calculated using Karl Pearson coefficient correlation.

Statistical package SPSS version 17.0 was used for the analysis, and *p*-value less than 0.05 was considered as significant.



Fig. 2 Try in centric (A) frontal view, (B) right lateral view, (C) left lateral view, (D) occlusal view.

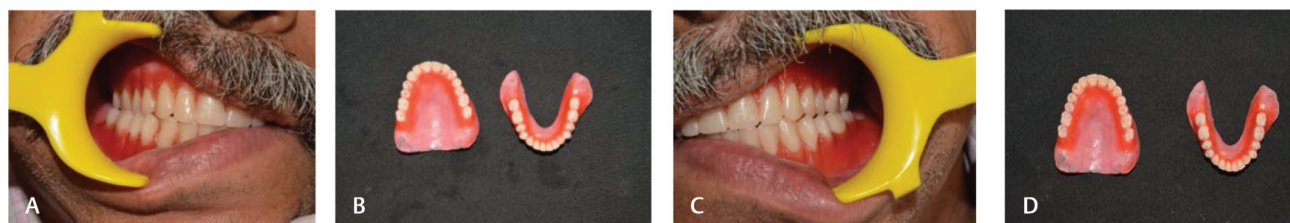


Fig. 3 Try in (A) right lateral, (B) occlusal contacts, (C) left lateral, (D) occlusal contacts.

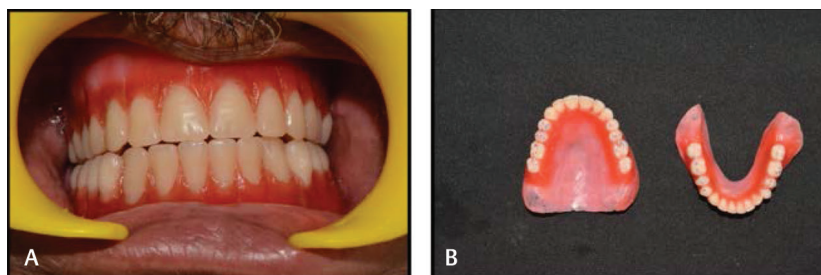


Fig. 4 Try in (A) protrusive, (B) occlusal contacts.

Results

In the present study, a total of 50 patients requiring complete denture were included. The results of the study showed that the average sagittal CP was 30.38° in the age group of 40 to 55 years and 32.58° in the age group of 56 to 70 years with average being 31.70° in the age group of 40 to 70 years. The average horizontal IP was 15.79° in the age group of 40 to 55 years and 16.04° in the age group of 56 to 70 years with average being 15.94° in the age group of 40 to 70 years. The average of right and left sagittal CP and horizontal IP varied with the average values (**Fig. 5**).

When the resiliency of the mucosa was assessed, 24% of the cases showed unyielding mucosa, while the rest 76% showed normal mucosa resiliency. When IG was assessed, it was found that 10% of the patients had deep IG, 40% had shallow, and 50% had medium IG.

When the correlation between the average sagittal CP and the total contacts (centric and eccentric) in the final processed denture in the patient's mouth was performed, a positive correlation was noted. The average sagittal CP (horizontal CG-average) showed a p value of 0.08, correlation

coefficient (r) was 0.25, average horizontal I.P.(lateral CG-average) showed a p value of 0.09, and correlation coefficient (r) was 0.24 for the total contacts (centric and eccentric) in the final processed denture in the patients' mouth.

Relation between sagittal CP, horizontal IP with bilateral balanced occlusion in two different age groups was found to be statistically significant (**Table 1**).

When the relation between sagittal CP, horizontal IP with bilateral balanced occlusion at various transforming stages in the articulator and patients' mouth was assessed, there was a positive correlation between the waxed up denture on the articulator and waxed up denture in the patients' mouth. Also, there was a positive correlation between the waxed up denture on the articulator and the processed denture after selective grinding-articulator (GAEC) (**Table 2**).

Results of the Gothic arch angle for the age group of 40 to 55 shows a p value of 0.872, and correlation coefficient (r) was 0.038 with the total contacts (centric and eccentric) in the final processed denture in the patient's mouth. The Gothic arch angle for age group 56 to 70 showed a p -value

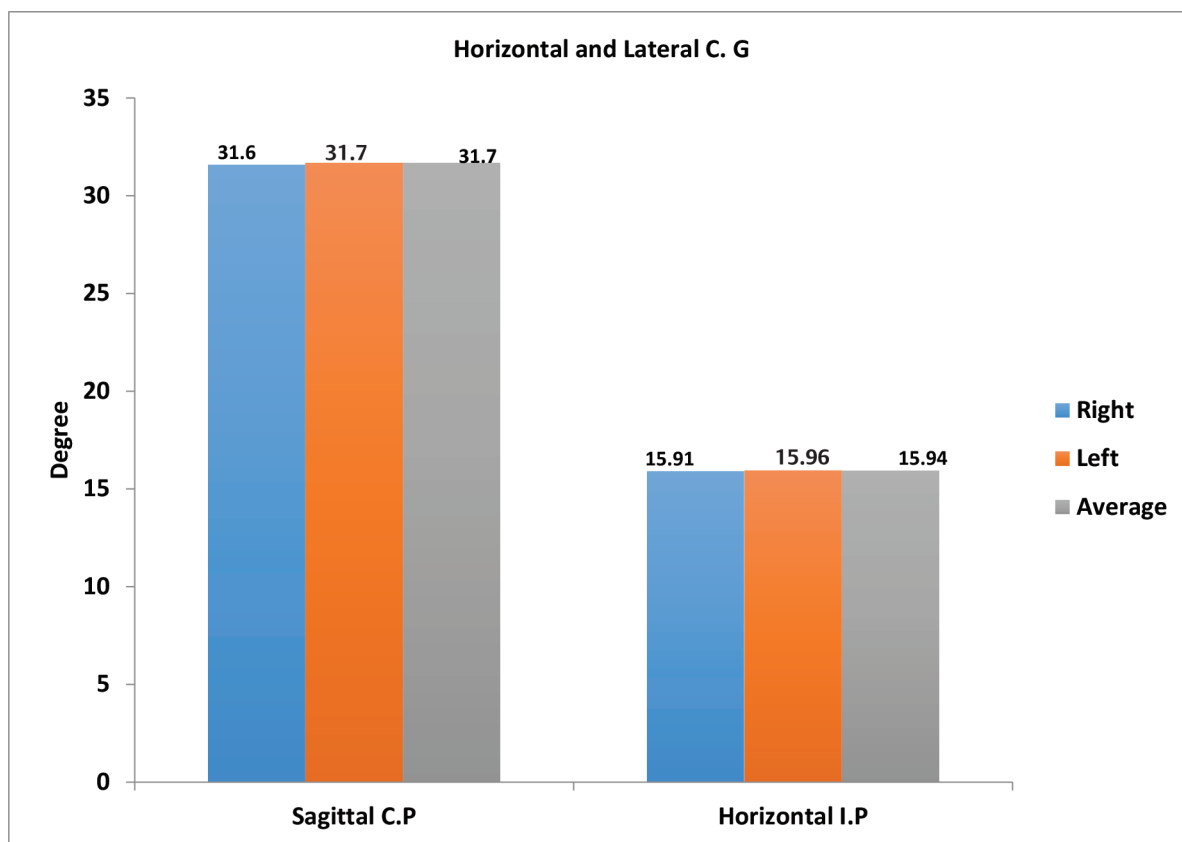


Fig. 5 Descriptive statistics of sagittal condylar path and horizontal incisal path.

Table 1 Relation between sagittal condylar path and horizontal incisal path with bilateral balanced occlusion in two different age groups

Age Group			Average horizontal IP (lateral CG-average)	Final prosthesis balanced occlusion total no. of contacts
40–55	Average sagittal CP (horizontal CG-average)	r	1.000	0.57
		p	< 0.001	0.009
		N	20	20
	Average horizontal IP (lateral CG-average)	r		0.57
		p		0.009
		N		20
56–70	Average sagittal CP (horizontal CG-average)	r	0.95	0.03
		p	< 0.001	0.88 (NS)
		N	30	30
	Average horizontal IP (lateral CG-average)	r		0.02
		p		0.92 (NS)
		N		30

Abbreviations: CG, condylar guidance; CP, condylar path; IP, incisal path.

Note: Boldface values indicate that the study result is statistically significant.

of 0.930 and correlation coefficient (r) was -0.017 , with the total contacts (centric and eccentric) in the final processed denture in the patients' mouth. Increase in vertical dimension was between 0.0 and 1.0 mm for 20 patients, between 1.1 to 1.5 mm for 11 patients, and between 1.5–2.0 mm for 19 patients.

The eccentric contact in the final processed denture in the patients mouth between the right lateral and left lateral for the condylar inclination of 20 to 30° showed a p value of 0.001 and correlation coefficient (r) of 0.696. The eccentric contact in the final processed denture in the patients mouth between the right lateral and left lateral for the condylar

Table 2 Relation between sagittal condylar path and horizontal incisal path with bilateral balanced occlusion at various transforming stages in the articulator and patients' mouth

		WD articulator total	WD mouth total	DAEC total	GAEC total
Average sagittal CP (Horizontal CG-average)	r	0.26	0.19	- 0.005	0.054
	p	0.07 (NS)	0.18(NS)	0.97 (NS)	0.71 (NS)
	N	50	50	50	50
Average horizontal IP (lateral CG-average)	r	0.21	0.18	- 0.03	0.02
	p	0.14 (NS)	0.21(NS)	0.86 (NS)	0.87 (NS)
	N	50	50	50	50
WD articulator total	r		0.77	0.42	0.68
	p		<0.001	0.002	<0.001
	N		50	50	50
WD mouth total	r			0.21	0.54
	p			0.14	< 0.001
	N			50	50
DAEC total	r				0.66
	p				< 0.001
	N				50

Abbreviations: CG, condylar guidance; CP, condylar path; IP, incisal path.

Note: Boldface values indicate that the study result is statistically significant.

inclination of 30 to 40° showed a *p* value of 0.000 and correlation coefficient (*r*) of 0.878.

When the relation between the sagittal CP with the working and balancing contacts in the final processed denture in the patients' mouth with respect to the two different age was assessed, it was found to be statistically significant (►Table 3).

The correlation between the average sagittal CP for two groups of condylar inclinations, that is, 20 to 30° and 30 to 40° with the total eccentric contacts present between working side and balancing side in the final prosthesis in the patients' mouth, showed a positive correlation that was statistically significant (*p* value < 0.001). The correlation between the average sagittal CP and the average horizontal IP was positive and statistically significant (*p* value 0.000). The number of centric and eccentric contacts changed during various stages of denture fabrication (►Table 4).

The average sagittal CP (horizontal CG-average) and IG (protrusive) were compared and a *p* value of 0.67 and a correlation coefficient (*r*) of - 0.062 was found statistically. The horizontal IP (lateral CG-right) and left wing (residual limb [RL] IG) when compared showed a *p* value of 0.57 and a correlation coefficient (*r*) of - 0.082. On comparing the horizontal IP (lateral CG-left) and right wing (lower limb [LL] IG), a *p* value of 0.04 and a correlation coefficient (*r*) of - 0.29 was recorded. Protrusive IG and its relation with average sagittal CP (horizontal CG) was assessed and simple linear regression suggested that incisal protrusive values are not the significant predictor of sagittal values (►Table 5).

The right lateral working side contact and the right lateral balancing side contact when compared showed a *p* value of 0.016 and correlation coefficient (*r*) of 0.339. The left lateral working side contact and the left lateral balancing side contact comparison showed a *p* value of < 0.001 and correlation coefficient (*r*) of 0.650. Descriptive statistics of sagittal CP and horizontal IP in two different age groups were found to be significant for left and average sagittal CP and horizontal IP (►Table 6).

Discussion

Successful treatment of edentulous patient is based on long-term reestablishment of function and on the preservation of the alveolar bone, providing harmony between the occlusal surfaces of the artificial teeth and the condylar paths, which plays a significant role in both function and preservation of remaining natural tissues. Factors involved in achieving balanced occlusion are CG, IG, cuspal angulation, compensating curve, and plane of occlusion.

Among all these factors, CG and IG are the most important factors which have maximum influence in achieving balanced occlusion. Clinicians cannot modify the values of CG as it is obtained from patient. Other factors can be modified by clinicians to achieve balanced occlusion. The objective of the present research was to study the sagittal CP and horizontal IP, and ascertain the possible relation between these two factors with bilateral balanced occlusion."

Table 3 Relation between Sagittal condylar path with working and balancing contacts in the final processed denture in the patients mouth with two different age

			Groups		
Age group			Final prosthesis LL	Average sagittal CP (horizontal CG–average)	
40–55	Final prosthesis RL	R	0.723	0.327	
		P	0.000 sig	0.159	
		N	20	20	
	Final prosthesis LL	R		0.400	
		P		0.081	
		N		20	
56–70	Final prosthesis RL	R	0.872	0.077	
		P	0.000 sig	0.684	
		N	30	30	
	Final prosthesis LL	R		0.144	
		P		0.448	
		N		30	

Abbreviations: CG, condylar guidance; CP, condylar path; LL, left lateral; RL, right lateral.

Note: **0.000 Sig** stands for statistically significant value.

Lott clarified Hanau's laws of occlusion by relating them to the posterior separation which results from guiding factors. According to this concept:¹

- The greater the angle of the condylar path, the greater is the separation.
- The greater the angle of the overbite, the greater is the separation in the anterior region and the posterior region.
- The greater the separation of the posterior teeth, greater is the compensating curve.
- Posterior separation beyond the ability of compensating curve to balance the occlusion requires the plane of orientation.
- The greater the separation of the posterior teeth, the greater must be the height of the cusps of posterior teeth.
- In patients with a steep CG, the IG should be decreased to reduce the amount of jaw separation produced during protrusion and vice versa

IG is a variable factor until esthetics has been established. After that, it becomes a fixed factor. The IG is usually expressed in degrees of angulation from the horizontal by a line drawn in the sagittal plane between the incisal edges of the maxillary and mandibular incisor teeth when closed in centric occlusion. It ranges anywhere from 0 degree to greater than 45degrees. If the IG is steep, it requires steep cusps, steep occlusal plane, or steep compensating curve to affect the occlusal balance.

For complete dentures, the incisal guidance should be as flat (0degrees) as esthetics and phonetics will permit because of reduction of lateral inclines.² When the arrangement of the anterior teeth necessitates a vertical overlap, a compensating horizontal overlap should be set to prevent dominant incisal guidance (anterior interference)

from upsetting the occlusal balance on the posterior teeth. In maximum interception, the anterior teeth is usually arranged without contact. Contact between anterior teeth will occur when the mandible moves in a lateral or protrusive direction during articulation. The greater the horizontal overlap, the lower the angle of inclination, as long as the vertical overlap remains the same.

Since the CG and IG have been established, the plane of occlusion, compensating curve, and cuspal inclination must be harmonized with these factors. Out of these five factors of balanced occlusion, the dental specialist can control only four factors since the CP is fixed by the patient. Of the four, he can control the IG, and the plane of occlusion can be altered only to a slight amount because of esthetics and physiologic factors.

To achieve accurate CG and record accurate mandibular movement, it is important to record the condylar inclination on both right and left side separately. To achieve that ideal, articulator is fully adjustable articulator, but semiadjustable articulator also serves the purpose to an extent. In present study, Artex semiadjustable articulator was used with adjustable guide table.

According to the results of the present study, the average sagittal CP (horizontal CG–average) and the average horizontal IP (lateral CG–average) have statistically significant relation with bilateral balanced occlusion in edentulous subjects of 40 to 55 years age group (►Table 1). Hence, it can be concluded that bilateral balanced occlusion is more predictable in younger age group of people as compared with older individuals. This could be explained by the fact that the mandibular movements and the acquired muscular control are more stable in younger subjects. Moreover, making definitive lateral movements and its control is slightly difficult in older individuals, since as age increases the neuromuscular

Table 4 Descriptive statistics of centric and eccentric contacts at various stages of denture fabrication

	N	Minimum	Maximum	Mean	SD
WD articulator CC	50	12.00	29.00	20.5000	3.69914
WD articulator Ecc C RL	50	9.00	21.00	14.3000	3.32124
WD articulator Ecc C LL	50	8.00	20.00	13.3600	3.57291
WD articulator Ecc C P	50	9.00	27.00	19.2600	5.00127
WD articulator Ecc C T	50	27.00	66.00	46.8000	10.23798
WD articulator Total	50	38.00	91.00	66.7000	12.98390
xWD mouth CC	50	12.00	32.00	21.3200	5.34690
WD mouth Ecc C RL	50	6.00	29.00	15.5400	5.36888
WD mouth Ecc C LL	50	6.00	23.00	15.6600	4.88066
WD mouth Ecc C P	50	10.00	27.00	20.1400	4.50854
WD mouth Ecc C T	50	27.00	70.00	51.1600	12.90999
WD mouth Total	50	43.00	102.00	72.4800	16.82350
PDA CC	50	4.00	23.00	14.1800	4.09425
PDAEC RL	50	1.00	25.00	12.1600	4.81647
PDAEC LL	50	1.00	26.00	11.7200	4.76826
PDAEC P	50	3.00	25.00	15.6000	5.71786
PDAEC T	50	8.00	70.00	39.9000	13.92289
PDA TOTAL	50	19.00	90.00	53.9800	16.68005
SGA CC	50	12.00	27.00	19.6200	3.91173
SGAEC RL	50	7.00	25.00	15.6200	5.07853
SGAEC LL	50	8.00	24.00	17.3000	4.70887
SGAEC P	50	9.00	33.00	21.6000	5.45482
SGAEC T	50	28.00	80.00	54.4800	13.53942
SGA total	50	44.00	101.00	74.1000	16.61601
Final prosthesis CC	50	13.00	32.00	21.3400	6.57953
Final prosthesis EC RL	50	6.00	23.00	16.3800	4.56200
Final prosthesis EC LL	50	6.00	24.00	15.6600	4.73204
Final prosthesis P	50	11.00	32.00	19.0800	5.74577
Final prosthesis EC total	50	30.00	79.00	51.2800	13.24809
Final prosthesis total	50	47.00	105.00	72.3800	18.51628

Abbreviations: LL, left lateral; RL, right lateral; SD, standard deviation.

Table 5 Protrusive incisal guidance and its relation with average sagittal condylar path (horizontal condylar guidance)

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	32.51	1.94		16.75	< 0.001
	Incisal guidance S	-0.08	0.19	-0.06	-0.43	0.67 (NS)

Note: Boldface values indicate that the study result is statistically significant. Dependent variable: average sagittal = $32.51 - 0.008 \times$ protrusive incisal guidance.

coordination decreases. The results of the study done by Shah et al showed decrease in condylar inclination as age advances.³ In contrast to this, the present study showed increase in condylar inclinations to minimal extent as age advances. Also, horizontal condylar values showed a decreasing trend with increasing age.³ In contrast to this, the present study showed increase in horizontal condylar values as age increases is in

agreement with the results of Baquaien et al,⁴ Katsavrias et al.,⁵ and Prasad et al.⁶ The average CG (**►Table 6**) values obtained in the present study are almost similar to study using wax records by Jose de Santos et al.⁷

Even though what matters is the balanced occlusion in the final prosthesis inside the patient's mouth, in order to achieve the same, it is also important that meticulous care

Table 6 Descriptive statistics of sagittal condylar path and horizontal incisal path in two different age groups

	Age	N	Mean	SD	Mean difference	95% CI		T	Df	p-Value
						lower	Upper			
Sagittal CP (Horizontal CG-right)	40-55	20	30.75	3.35	-1.42	-3.47	0.63	-1.39	48	0.17 (NS)
	56-70	30	32.17	3.64						
Sagittal CP (horizontal CG-left)	40-55	20	30.00	4.87	-2.83	-5.25	-0.41	-2.35	48	0.02
	56-70	30	32.83	3.64						
Average sagittal CP (horizontal CG-average)	40-55	20	30.38	3.47	-2.21	-4.15	-0.27	-2.29	48	0.03
	56-70	30	32.58	3.25						
Horizontal IP (lateral CG-right)	40-55	20	15.84	0.42	-0.16	-0.41	0.10	-1.23	48	0.22 (NS)
	56-70	30	16.00	0.45						
Horizontal IP (lateral CG-left)	40-55	20	15.75	0.61	-0.33	-0.63	-0.03	-2.21	48	0.03
	56-70	30	16.08	0.46						
Average horizontal IP (lateral CG-average)	40-55	20	15.79	0.43	-0.24	-0.48	0.00	-2.04	48	0.04
	56-70	30	16.04	0.40						

Abbreviations: Abbreviations: CG, condylar guidance; CP, condylar path; IP, incisal path; SD, standard deviation.

Note: Boldface values indicate that the study result is statistically significant.

be taken during various stages of denture fabrication in the laboratory.⁸ The present study also focuses on relation between sagittal CP, horizontal IP with bilateral balanced occlusion at various transforming stages of denture fabrication. Statistically significant relations were found in balanced occlusion between waxed up denture on articulator, processed denture on articulator, and processed denture on articulator after selective grinding. Also, significant relation is found to be present between balanced occlusion in waxed up denture in the mouth and processed denture after selective grinding on the articulator as well as processed denture on articulator and processed denture after selective grinding. These results suggest that care should be taken in each transformation steps to reach the final goal of achieving optimal balanced occlusion.

It is possible to correct the processing errors which lead to decrease in number of established contacts during waxed up denture stage, and by meticulous execution of selective grinding, it is possible to re-establish the optimum balanced occlusion required for the stability of the complete denture prosthesis (► **Table 4**). As per the observations of the present study, there is no significant relation between Gothic arch angles with the balanced occlusion and lateral condylar inclinations. Gothic arch tracing direction and movements are more controlled by neuromuscular coordination than condylar inclinations.

The total number of eccentric contacts showed statistically significant relation between working and balancing side in both the groups of condylar inclination, that is, 20 to 30 degrees and 30 to 40 degrees. It is also shown that these contacts are independent of average condylar inclinations. The results were correlating in both the age groups. The harmony between working side and balancing side contacts during lateral excursive movements will help in the functionality of the complete denture prosthesis with improved stability. It is also important to visualize the

working and balancing side contacts as a contributing factor to the balanced occlusion along with centric and protrusive contacts.

In the present study, there is a positive correlation between average sagittal CP and average horizontal IP. This could be justified with the fact that lateral condylar inclination is calculated by using Hanau's formula, based on the horizontal inclination of the patient. Alternative methods like using lateral records for adjusting the individual lateral condylar inclinations, that is, left lateral record to adjust the right lateral condylar inclination and vice versa maybe used in the future studies to observe the difference in values. The results of the study, by Preti et al,⁹ related to sagittal condylar path are in concurrence with the values obtained from the present study. An attempt has been made to check whether there is any relation between Gothic arch angles with bilateral balanced occlusion as well as with average horizontal incisal path in two different age groups. Also, the corresponding Gothic arch lateral wings were compared with horizontal CG of the opposite side. However, no statistical significance was found to correlate these aspects.

Another aspect of this study is comparison of average sagittal condylar path with protrusive IG on the articulator and individual horizontal IP with corresponding lateral wing of IG. A weak inverse correlation was observed between the horizontal incisal path (lateral CG-left) and the right wing (LLIG).

Limitations of the Study

In the present study, semiadjustable articulator was used. But it is known from literature that semiadjustable articulator cannot adjust all the records from the patient. Intercondylar distance is also fixed in these articulators. Lateral records were not used to program the articulator. Semianatomic teeth were used for all the individuals. In the present study,

both male and female participants were taken, but there was no equal distribution of subjects from both genders. No comparison was done between results obtained from both the groups. Minimal selective grinding was done after processing to compensate the processing errors, which are inevitable to re-establish the optimal balanced occlusion. Cuspal angulation depends on CG and IG. Steeper angulations require steep inclines of cusps and shallow guidance requires shallow cusp teeth. In this study, semianatomic teeth were used.

Scope for Further Research

Future studies can use fully adjustable articulators to evaluate the CG more accurately. Future studies can focus on using intra-oral tracing and pantographic methods for recording more accurate sagittal CG. Further studies can include lateral records in their study and compare the results obtained by the present study. Future studies can be undertaken to use teeth suitable to a particular patient's CG. Future studies can be undertaken to find out whether any relationship between CG and gender exists. In further studies, both male and female participants can be taken with check bite as an alternative methodology to equal the distribution of subjects from both genders.

Clinical Implications

The observations of the present study may help clinicians to design prosthesis and plan their treatment which can benefit the patients by minimizing the rate of bone resorption, preserving the remaining natural tissues, and improving the functionality by adequate stability with optimal balanced occlusion.

An average sagittal CP in Indian population of age group 40 to 70 years can be used as a mean value in setting the horizontal condylar inclination of the articulator during fabrication of Balanced complete denture prosthesis. An average horizontal IP in Indian population of age group 40 to 70 years can be used as a mean value in setting the lateral condylar inclination of the articulator during fabrication of balanced complete denture prosthesis.

Conclusion

This study results showed increase in condylar inclinations to minimal extent as age advances. According to the results of the present study the Average Sagittal condylar path (Horizontal condylar guidance- Average) and the Average Horizontal Incisal path (Lateral condylar guidance-Average) are having statistically significant relation with Bilateral Balanced occlusion in edentulous subjects of 40 to 55 years age group.

Statistically significant relations were found in balanced occlusion between waxed up denture on articulator, processed denture on articulator, and processed denture on articulator after selective grinding. Also, significant relation is found to be present between balanced occlusion in waxed up denture in the mouth, processed denture after selective grinding on the articulator, processed denture on articulator, and processed denture after selective grinding.

As per the observations of the present study, there is no significant relation between Gothic arch angles with the balanced occlusion and lateral condylar inclinations. Gothic arch tracing direction and movements are more controlled by neuromuscular coordination than condylar inclinations.

The total number of eccentric contacts showed a statistically significant relation between working and balancing side in both the groups of condylar inclination, that is, 20 to 30 degrees and 30 to 40 degrees. It is also shown that these contacts are independent of average condylar inclinations. The results were correlating in both the age groups. The harmony between working side and balancing side contacts during lateral excursive movements will help in the functionality of the complete denture prosthesis with improved stability.

A positive correlation between average sagittal CP and average horizontal IP. A weak inverse correlation is observed between the horizontal IP (lateral CG-left) and right wing (LLIG).

Note

This original research has been submitted to Nitte (Deemed to be University) and awarded with PhD in the Faculty of Dental Sciences to K.P.D.

Conflict of Interest

None declared.

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