

INVESTIGATION OF THE RELATIONSHIP BETWEEN CONDYLAR SLOPE SIZE IN PANORAMIC RADIOGRAPHIC IMAGES AND INTEROCCLUSAL RECORDS IN PROTRUSIVE MOVEMENTS

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ABSTRACT

Aim: The condylar guidance is created by the condylar and the articulator disc when it passes through the glenoid fossa. If the condylar slope is not properly recorded, it can lead to occlusal interactions. In panoramic radiography, the articulatory line is well visible; it can therefore be used to determine the condylar slope. The results of the studies were contradictory. Therefore, this study was conducted with the aim of correlating the condylar slope size in panoramic radiographic images and interocclusal records in protrusive movements.

Materials & Method: This is a descriptive-analytic study. Both jaws were molded in patients. The upper jaw's cast was mounted using FaceBow record on the articulator and the lower cast was mounted by using maximum intercuspation relationship. To record protrusive movements, the patient was asked to move their mandible to the point in which the jawbone were edge to edge. Condylar slope was also determined on radiographic images. Data was analyzed by SPSS 16 software.

Results: The findings indicated that mean slope of the right interocclusal record was 33.9 ± 19.3 and for the left side it was 33.79 ± 3.22 , right panoramic radiography has been 35.88 ± 3.37 and for the left side it was 35.93 ± 3.27 . The correlation between the gradients recorded by panoramic radiography and interocclusal records in protrusive movements in the right condyle was ($r = 0.81, p < 0.001$) and it was ($r = 0.83, p < 0.001$) in the left condyle.

Conclusion: The tests showed a significant difference in the difference in the condylar slope in panoramic radiography and interocclusal recording method in the left and right sides.

Key words: Condylar, Condylar slope, Panoramic.

Introduction

The purpose of the prosthodontic rehabilitation is to construct a dental prosthesis that is balanced with the individual's stomatognathic system. One of the most remarkable considerations in this remodeling of the teeth is to consider the condylar slope.¹ When the mandible performs protrusive or sideways movements, condyle moves according to the prominence along the route, the angle which is made by condyle with a horizontally-grounded surface is known as the condylar slope, which varies from one person to another.^{2,3} Condylar guidance is the mandible guidance developed by the condyle and the articulator disk when it passes through the glenoid fossa chamber.⁴ In Inter-occlusal records, the purpose of the mandibular pro-motion movements is to arrange the condylar articulator components so that the created condylar slope is similar to that of the condyle slope that exists in the patient's temporomandibular joint so that there is no occlusal problems after the prosthesis is made. If the condylar slope is not recorded correctly, it can lead to occlusal interferences. It can also lead to an increase in the time of admission and the regulation of occlusion by the dentist, which in turn can cause fatigue and frustration for the dentist and patient.⁵ Various intraoral and extraoral methods have been used to record the condylar slope and the condylar pathway, which is usually used for the treatment of toothless patients.^{6,7} Central and noncentric mandibular relationships can be recorded by oral recording methods with wax, graphical methods, functional methods,

and cephalometric methods.⁸ In spite of using these precise recording methods, the sources of errors increase in laboratory processes, as a result of factors such as instability of materials, changes that occur during set-up or changes during polymerization.⁹ Accordingly, a study was conducted to verify the reliability of inter-occlusal records by Wax, which was determined in three separate tests according to this study and there were different records in these three experiments and the results were different so the mentioned factors are very influential.¹⁰ In addition, if the patient moves his mandible laterally through protrusive movements, then the record of the path and the condylar slope will change.¹¹ The production of electro-optical devices partly resolved the problems of clinical methods to determine the condylar slope.¹² However, clinical use of these methods requires patient's neuro-occlusive control and operator's skill. And the use of these methods in third world countries like Iran and India is not easily feasible and is not also economic. Panoramic radiography is one of the most common radiographs used in dentistry, in this kind of radiography, the articulation line is well known, so this line can be used to determine the condylar slope in semi-adjustable articulator. Various studies have been carried out in this regard,¹³⁻¹⁴ but the results of these studies contradict and different outcomes have been achieved. Considering the importance of condylar slope in dentistry, especially prosthetic dentistry, Therefore, this study was conducted with the aim of correlating the condylar slope size obtained

in panoramic radiographic images and interocclusal records in protrusive movements.

Materials & Method

This study is a descriptive-analytical study. According to Tannamala *et al.*⁷ the following relationship was used to determine the sample size, with a 10% drop, the sample size was 42. The samples were selected from the Prosthetic and Radiology Department of the Faculty of Dentistry, Yasouj University of Medical Sciences.

$$n = \frac{(Z_{1-\frac{\alpha}{2}})^2 \sigma^2}{d^2} = \frac{(1.96)^2 (5.01)^2}{(1.6)^2} = 37.6 \approx 38$$

Absence of temporomandibular joint disorders (TMD), skeletal abnormalities and neuromuscular coordination, class-one parasite relationship, complete dental series, lack of abrasion and extensive restoration were considered as inclusion criteria and patients' unwillingness to continue to participate in the research was chosen as the exclusion criteria. First, both jaws of the patients were molded using irreversible hydrocolloids. Then they were quickly cast using gypsum acetone (company and country). The maxillary casts were mounted with a semi-adjustable articulator using the FaceBow record and the lower cast was mounted using maximum intercuspation record of the patient. To record protrusive movements, the patient was asked to move his mandible to the point where the jaw connects to the edge to edge position and then, using the Aluwax, these movements were recorded. The protrusive relationship was re-examined and confirmed before adjusting the condylar slope. It should be noted that all the mentioned items were performed by one operator. All panoramic radiographic images were made at the Department of Radiology by one person and with one device (cranex D-Finland-hinsilky). Images were printed with kVp68 and mA10 and at 100% scale. In these images, the lowest outline point of left or right orbital and left and right porion point (the highest point in the outer ear hole) were also marked. And the horizontal Frankfort line was drawn by connecting these two landmarks. On the other hand, the outline of the articular prominence and the pathway of the fossa glenoid was drawn on the acetate sheet, in this specified path, the highest point of the articular prominence and the lowest point was determined, and then these two points were connected by a line that the slope of this line represented the condylar slope. The angle formed between this line and the reference line (Frankfurt) represents the condylar slope angle. After the end of the work, the collected data was analyzed by SPSS 16 software and T (t test) was used for the comparison analysis between groups.

Results

Table of descriptive values

	Descriptive Values		
	Min.	Max.	SD ± Mean
Right Interocclusal Record	27	40	33.9 ± 3.19
Left Interocclusal Record	27	40	33.79 ± 3.22
Right Panoramic Radiography	29	42	35.88 ± 3.27
Left Panoramic Radiography	28	41	35.93 ± 3.27

Table 1: Table of descriptive values

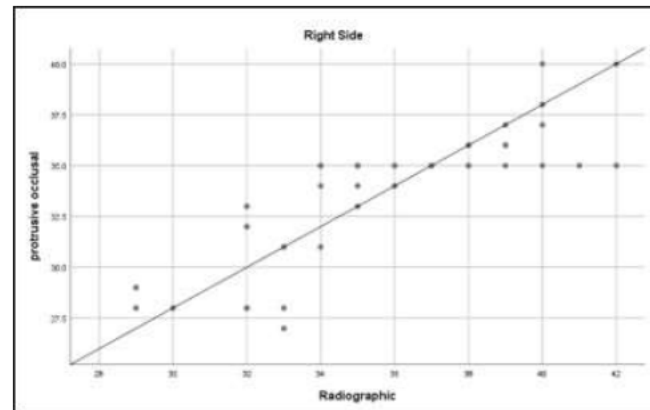


Figure 1: Condylar slopes are compared in interocclusal records and panoramic radiographies in the right side.

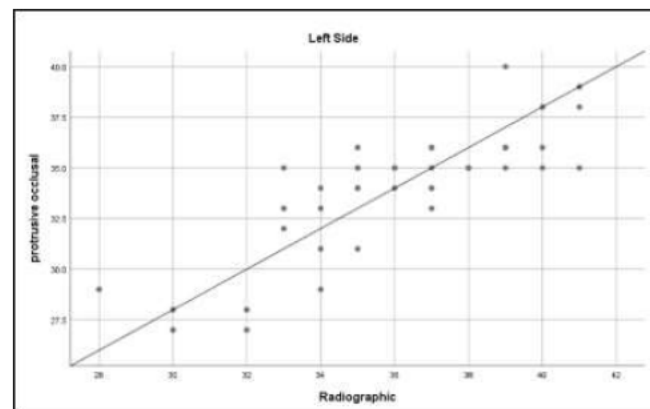


Figure 2: Condylar slopes are compared in interocclusal records and panoramic radiographies in the left side.

The correlation between the gradients recorded by panoramic radiography and interocclusal records in protrusive movements in the right condyle ($r = 0.81$, $p < 0.001$) and in the left condyle ($r = 0.83$, $p < 0.001$).

Independent T-test was used to determine whether the condylar slope obtained in panoramic radiography equals the condylar slope obtained in interocclusal registration methods. Results were recorded in Table 2. The results of this test showed a significant difference in the size of the condylar slopes in the panoramic radiography and the interocclusal records in the right and left sides.

Comparison of condylar slope in panoramic radiography and interocclusal records	T	P	Mean Difference	95 % CI	
				Lower	upper
The results of the comparison on the right side	-2.75	0.007	-1.97	-3.4	-0.55
The results of the comparison on the left side	-3.02	0.003	-2.14	-3.5	-0.73

Table 2: Comparison of condylar slope in panoramic radiography and interocclusal records.

Discussion

The mandible guidance defines Glenoid Fossa as the condylar slope by Condyle and articular disk.⁴ The relationship between the traced route by mandible in mandible displacements and the morphology of occlusal surfaces has been studied by many observations.^{10,15,16} Interocclusal protrusive record can record the impact of the condyle route beyond the mandibular displacements.⁷ The successive records show the angles of condylar guidance variations between registration materials, operators and articulators.^{17,18} Among the most important aspects of the condylar guidance that affects the occlusal surface of the posterior teeth are the slope of the advancing route of the Condyle and the lateral movement of the lower jaw. The slope of condyle's route in the protrusive movement in different patients can differ from the steep slope to the slow one and this gradient makes a 30.4 degree angel with horizontal reference plan (43 mm above the incisal edge of the upper central tooth). If the gradient is steep, the height of the cusp may be higher. If the slope is low, the height of the cusp should be less.¹⁹ The results of this study show that there is a significant difference in the difference between the condylar slope in panoramic radiography and inter-occlusal records in the two right and left sides. Several studies have examined this issue. For example, a study was conducted by Galagali *et al.* in 2017 in India on 120 dental patients with the aim of comparing the condylar slope obtained in panoramic images with interocclusal recording methods, it was found that panoramic radiography is not a good alternative to interocclusal recording method in determining the condylar slope. This finding is similar to the results of the present study. They also consider lateral cephalometric radiography to be more suitable for determining the condylar slope.²⁰ Godavarthi *et al.*, in 2015, compared the condylar slope obtained in panoramic images with interocclusal recording methods. It was found that the information obtained from the determination of condylar slope in the panoramic method only in the case of anesthetized patients can be used as an alternative to the interocclusal recording method.¹³ Also, during a review by Kwon *et al.* In South Korea in 2017 with the aim of comparing the condylar slope obtained in panoramic images by interocclusal recording methods on dental subjects, It was found that the angle obtained in radiographic images was on average about 6 degrees higher than the inter-occlusal recording method.²¹ This value in the current study has been 2 degrees. Twenty-four patients were examined during a study by Shah *et al.* In 2014 with

the aim of comparing the condylar slope obtained in panoramic images with interocclusal recording methods in India on toothless patients and It was found that the condylar slope obtained from the panoramic radiography was higher than the interocclusal recording method, and radiographic images could not be used to determine the condylar slope on the semi-adjustable articulator.²²

According to a survey by Shetty *et al* in 2013 in India the data obtained from condylar slope determination in the panoramic and interocclusal recording methods showed that condylar slope obtained from panoramic radiography shows a higher rate than the one obtained from interocclusal recording methods. But in general, the average of the slopes in both methods was close to each other.²³ This finding is in line with the results of this study. In a study by Prasad *et al.* in 2012 aimed at comparing the condylar slope obtained in panoramic images with interocclusal recording methods in India, it was concluded that the information obtained from the panoramic radiography method can be used instead of the interocclusal recording method to determine the condylar slope on the semi-adjustable articulators.¹⁴ The findings of their study is not consistent with our findings. During a review by Tannamala *et al* in 2012 in India aimed at comparing the condylar slope obtained in panoramic images with interocclusal recording methods, the obtained data showed that the angles obtained in panoramic images were on average about 4 degrees higher than the interocclusal recording methods and it was concluded that we might be able to use these images to determine the condylar slope.²³

Conclusion

The results of this study show that there is a significant difference in the difference between the condylar slope in panoramic radiography and interocclusal records in the two right and left sides. Therefore, panoramic radiography is not a reliable diagnostic tool for measuring condylar slope.

References

1. Isaacson D. A clinical study of the condyle path. J Prosthet Dent. 1959;9(6):927-935.
2. Pelletier LB, Campbell SD. Comparison of condylar control settings using three methods: a bench study. J Prosthet Dent. 1991;66(2):193-200.
3. Okeson JP. Management of temporomandibular Disorders and Occlusion. 3rd ed. St. Louis: Mosby, 1993.
4. The glossary of prosthodontic terms. J Prosthet Dent. 2005;94:10-92.
5. Rothstein JR. Condylar guidance setting on articulators from protrusive records. J Prosthet Dent. 1972;28(3):334-335.
6. Hickey JC, Zarb GA, Bolender CL. Boucher's Prosthodontic Treatment for Edentulous Patients. 9th ed. St. Louis: CV Mosby. 1985;415.
7. Tannamala PK, Pulagam M, Pottem SR, Swapna B. Condylar guidance: correlation between protrusive interocclusal record and panoramic radiographic

- image: a pilot study. *J Prosthodont.* 2012;21(3):181-184.
8. Preti G, Scotti R, Brusca C, Carossa S. A clinical study of graphic registration of the condylar path inclination. *J Prosthet Dent.* 1982;48(4):461-466.
9. Harcourt JK. Accuracy in registration and transfer of prosthetic records. *Aust Dent J.* 1974;19(3):182-190.
10. Craddock FW. The accuracy and practical value of records of condyle path inclination. *J Am Dent Assoc.* 1949;38(6):697-710.
11. Boos RH. Condylar path by roentgenograph. *J Prosthet Dent.* 1951;1(4):387-392.
12. Gonzalez JB, Kingery RH. Evaluation of planes of reference for orienting maxillary casts on articulators. *J Am Dent Assoc.* 1968;76:329-336.
13. Godavarthi AS, Sajjan MCS, Raju AVR, Rajeshkumar P, Premalatha A, Chava N. Correlation of condylar guidance determined by panoramic radiographs to one determined by conventional methods. *J Int Oral Health.* 2015;7(8):123-128.
14. Prasad KD, Shah N, Hegde C. A clinico-radiographic analysis of sagittal condylar guidance determined by protrusive interocclusal registration and panoramic radiographic images in humans. *Contemp Clin Dent.* 2012;3(4):383-387.
15. Ortman HR. The role of occlusion in preservation and prevention of complete denture prosthodontics. *J Prosthet Dent.* 1971;25(2):121-138.
16. Gerber AB, Steinhardt G. Dental occlusion and the temporomandibular joint. 1st Ed. Chicago:Quintessence Pub Co. 1990;22.
17. Gross M, Nemcovsky C, Tabibian Y, Gazit E. The effect of three different recording materials on the reproducibility of condylar guidance registrations in three semi-adjustable articulators. *J Oral Rehabil.* 1998;25(3):204-208.
18. Gilboa I, Cardash HS, Kaffe I, Gross MD. Condylar guidance: correlation between articular morphology and panoramic radiographic images in dry human skulls. *J Prosthet Dent.* 2008;99(6):477-482.
19. Shillingburg HT, Sather DA, Wilson EL, Cain JR, Mitchell DL, Blanco LJ, *et al.* Fundamentals of fixed prosthodontics. 4th Ed. Hanover Park, IL:Quintessence Pub Co, 2012.
20. Galagali G, Kalekhan SM, Nidawani P, Naik J, Behera S. Comparative analysis of sagittal condylar guidance by protrusive interocclusal records with panoramic and lateral cephalogram radiographs in dentulous population: a clinico-radiographic study. *J Indian Prosthodont Soc.* 2016;16(2):148-153.
21. Kwon OK, Yang SW, Kim JH. Correlation between sagittal condylar guidance angles obtained using radiographic and protrusive occlusal record methods. *J Adv Prosthodont.* 2017;9(4):302-307.
22. Shah K, Patel JR, Chhabra T, Patel P. Correlation of the condylar guidance obtained by protrusive interocclusal record and panoramic radiographs in completely edentulous patients: an in vivo study. *Adv Human Biol.* 2014;4(2):50-56.
23. Shetty S, Babu CLS, Tambake D, Kumar GPS, Setpal AT. A comparative evaluation of condylar guidance value from radiograph with interocclusal records made during jaw relation and try-in: a pilot study. *J Indian Prosthodont Soc.* 2013;13(3):321-326.

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