ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT148

Evaluation of Reliability and Validity of Different Thicknesses of Occlusal Contact Registration Strips Vs Conventionally used Articulating Papers – An Invitro Study

Reshma Raju
Dental Officer
Army Dental Corps
Coimbatore, Tamil Nadu

Abstract:-

- ***Aim:***
To compare and evaluate the reliability and validity of different thicknesses of Occlusal Contact Registration Strips (OCRS) under simulated occlusal load.

- ***Settings and Design: In-Vitro Comparative Study***

- ***Materials and Methods:***
Articulated epoxy resin dental models obtained from completely dentulous patients were interposed with occlusal contact registration strip of various thicknesses and subjected to constant axial compressive load using universal testing machine. The photographs of consistent registration marks were subjectively assessed using a computer software.

- ***Statistical Analysis Used:***
Analysis of Variance (ANOVA) and post hoc mean multiple comparison using Dunnett T3 test.

- ***Results:***
The thinnest occlusal registration strip used in this study registered the highest average number of markings with a borderline statistically significant difference (*P*=0.06). The highest average area of markings was registered by the thickest strip, which had a near marginal significance (*P*=0.09), whereas the lowest average area was produced by the thinnest strip which was statistically significant (*P*=0.03).

- ***Conclusion:***
There exists a relationship between the thickness of an occlusal contact registration strip, the number and the area of the marks registered. The average number of marks registered was inversely proportional to the thickness of the occlusal indicator. Hence, the thinner the occlusal contact registration strip, the more reliable is the occlusal contact registration. The average area of occlusal contact registration mark varies proportionately to its thickness. Hence, the thickest occlusal contact registration strips were more valid for marking occlusal contacts.

Keywords:- *Occlusal Contact Registration Strips, Occlusion, Mark Area, Reliability, Validity.*

I. INTRODUCTION

The practice of performing routine analysis of occlusion and marking of occlusal contacts is empirical in dentistry. Occlusal indicators/ occlusal contact registration strips (OCRS) are used to locate and define occlusal contacts.[1] A plethora of materials have been used till date such as waxes, carbon paper, metal sheets, plastic sheets with colorants, acetate sheets, liquid contact pigments, occlusal sprays, typewriter ribbons, pressure sensitive films, silk strips as well as novel aids such as photo-occlusion, sonography, T-scan and virtual occlusal records. It is important to observe adequate static and functional occlusion during a prosthetic and restorative procedure for the preservation of dental, periodontal, articular, and muscular health.[2,3]

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Despite the plethora of available materials, articulating papers and foils remain the gold standard to which newer technologies are compared to and are commonly used.[4] Clinical observations and research work show that occlusal registration strips should possess a thickness range well below that of patients' perception levels (12.5- 100 µm). An ideal occlusal registration strip should be less than 21 µm thick and capable of plastic deformation.[5,6] Conflicting results have been published about the relationships between contact mark size and force magnitude, between mark size and product thickness, between proprioceptive response and the products.[7] At present, clinical judgement of the marks made by occlusal contact indicators is the only available method for assessing occlusal contacts. A clear idea regarding the validity and reliability of these materials can help in diagnosis and developing a harmonious restoration.[8,9] This invitro study aimed to compare and evaluate the reliability and validity of different thickness of Occlusal Contact Registration Strips (OCRS) under simulated occlusal load.

II. AIMS AND OBJECTIVES

To analyze the number and size of consistent registration marks produced by occlusal contact registration strips (8 µm, 12 µm and 16 µm) on the specimens and compare it with that of the conventionally used articulating papers (22 µm) invitro, which signify the "reliability" and "validity" respectively, of each strip on repeated usage.

III. MATERIALS AND METHODS

This study was assessed and approved by the Institutional Ethics committee of state Dental College and Hospital. The specimen used in the study consisted of epoxy resin casts of 15 completely dentulous patients mounted on a semi-adjustable articulator using their interocclusal records. Patients aged between 21- 30 years with periodontally healthy teeth, normal occlusal contacts, Angle's Class I Molar Relation, canine guided occlusion, ideal anterior overjet and overbite, healthy premolars and molars with opposing counterparts were included in this study. Patients with any evident malocclusion, deleterious habits, deep caries, restorations, prosthetic replacements, missing dentition, orthodontic treatments, and temporomandibular joint disorders were excluded from the study. The 3rd molars did not play a significant role in the study.[10]

Impressions were made using addition silicone elastomeric impression material (Elite P and P normal set; Zhermack, Rovigo, Italy) and poured with epoxy resin (Fortune Chemie Solutions Unlimited, Bilekahalli, Bangalore, India), which were mounted on semi adjustable articulators (HanauTM wide vue, Whipmix Corporation, Louisville, USA), along with their interocclusal record (MDM Corporation, Lalkuan, Delhi, India) in maximum intercuspation. Each Occlusal contact registration strip (of a particular thickness-8µ, 12µ, 16µ, 22µ) was placed in between the maxillary and mandibular casts covering the occlusal surfaces of the teeth by means of the Fix-clip Film forceps (Dr. Jean Bausch GmbH & Co. KG Oskar- Schindler- Straße4 Köln (Cologne, Germany). The articulated dental casts were subjected to constant axial compressive load of 150 N using Universal Testing Machine (UTM- 400KN FIE-UTES-40-HGFL) [Figure]. The apparatus for testing was ensured rigidity and tightly anchored during all cast interpretation testing. The UTM was calibrated and zeroed prior to data collection. A constant load of 150 N was applied over the specimens and each 'tap' was recorded as a stroke. This procedure was repeated five times to simulate the tapping of teeth as is done in the intraoral marking procedure. Each five-tap trial comprised one test.

A photography platform was arranged and the models with the marks were placed on the platform after the test. A tripod was modified to prevent motion and capture dimensionally and perceptively consistent photos. A 14-megapixel digital camera (Nikon D 3100, Nikon Inc., USA) was mounted on a tripod and placed directly over the cast. Focus and magnification, shutter speed (1/80 sec or 0.0125 sec), ISO (100) and aperture (f/8) were kept constant. Consistent lighting was maintained by an LED lamp. A total of 40 photographs of the upper and lower casts were obtained for each specimen. The end of the experimental strokes of all the 15 specimens produced 600 photographs for analysis.

The photographs were uploaded in a computer system and subjectively assessed. The consistent occlusal markings were identified and the inconsistent ones were disregarded. The number of resultant paper markings over the casts was counted and their mean was calculated for every thickness of the occlusal indicator. This value gave the "Reliability" factor of the registration strip. The consistent markings were magnified and boundaries of the images were traced using Image J software (developed at the National Institutes of Health, Washington, DC, USA) by an Image J Freehand Sketcher. The Image J Measure Command gave the number of pixels enclosed within the area of the sketch. This value implied the "Validity" factor of the registration strip. The descriptive statistics (Mean and standard deviation) of resultant values were tabulated [Table no.1], compared using ANOVA one way test and post hoc analysis was done using the Dunnett T3 test.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT148

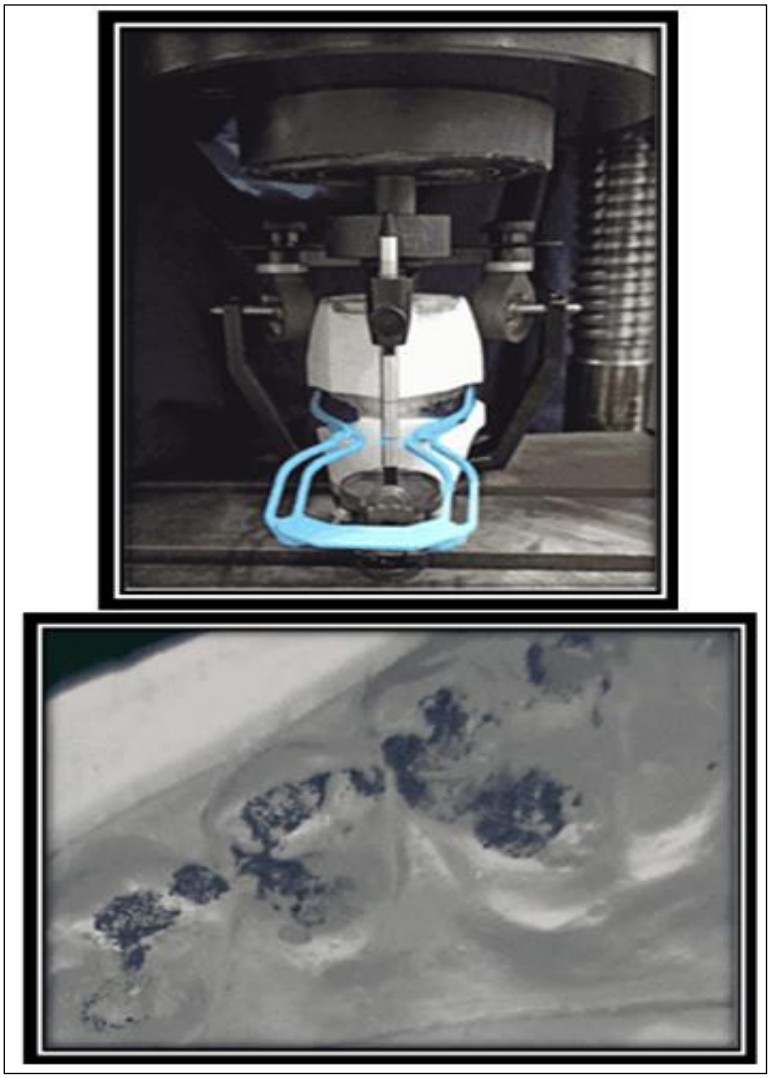

Fig 1: Application of Constant Simulated Occlusal Load over Occlusal Contact Registration Strips Interposed between the Articulated Specimen using Universal Testing Machine and the Resultant Registration Marks

IV. RESULTS AND OBSERVATIONS

Articulating foil (8 µ) registered the maximum number of consistent marks for every stroke applied followed by Articulating foil (12 µ) and Gnathofilm (16 µ), among the test groups [Table no.2]. A review of the plots showed almost a linear curve with a slight increase towards the mean value obtained through 8 µ [Graph 1]. The null hypothesis of homogeneity in mean values across the groups has been rejected, implying that there was a statistically significant difference among the mean values obtained between that of 22 µ and 8 µ. A post hoc analysis performed with Dunnett T3 test implied that the articulating foil (8 µ) registered the highest average number of distinct, consistent marks on every stroke [Table no.3]. The mean value difference was statistically significant with P = 0.06 (95% level of confidence).

Gnathofilm (16 µ) registered the maximum area of consistent marks for every stroke applied, followed by Articulating foil (12 µ) and (8 µ), when compared with the Articulating paper (22 µ) [Table no.4]. A review of the plots showed a decline in the mean values obtained through 16 µ through 12 µ and 8 µ depicting that area decreased proportionately with the thickness of the occlusal indicator [Graph 2]. The null hypothesis of homogeneity in mean values across the groups had been rejected implying that there was a statistically significant difference. Output from ANOVA test across the four groups comparing the mean among area of consistent marks depicted that the highest average area of markings registered were proportional to the thickest occlusal registration strip used in this study with a statistically significant difference (P=0.09) between the groups. Post hoc analysis performed with Dunnett T3 test [Table no.5] implied that Gnathofilm (16 µ) registered the greatest average area of distinct, consistent marks on every stroke with statistically significant difference (P= 0.09) whereas the Articulating film (8 µ) registered the lowest average area of distinct, consistent marks with statistically significant difference (p = 0.03).

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT148

Table 1:- Descriptive Statistics of the Number of Consistent Marks Produced by Different Thickness of OCRS (22 µ, 16 µ, 12 µ, 8 µ)

OCRS	NUMBER OF SPECIMEN	NUMBER OF MARKS		AREA OF MARKS	
		MEAN	SD	MEAN	SD
22 µ	15	3.3333	0.69864	115.2063	12.41925
16 µ	15	2.9000	0.66009	105.9895	6.02862
12 µ	15	3.1000	0.54116	104.7512	14.72387
8 µ	15	3.9333	1.48645	99.3242	16.37014
TOTAL	15	3.3167	0.98276	115.2063	12.41925

Table 2:- Mean Comparison among Number of Consistent Marks Produced by Different Thickness of OCRS (22 µ, 16 µ, 12 µ, 8 µ)

	SUM OF SQUARES	DF	MEAN SQUARE	F	SIG
BETWEEN GROUPS	9.017	3	3.006	3.509	0.021
WITHIN GROUPS	47.967	56	0.857		
TOTAL	56.983	59			

Graph 1

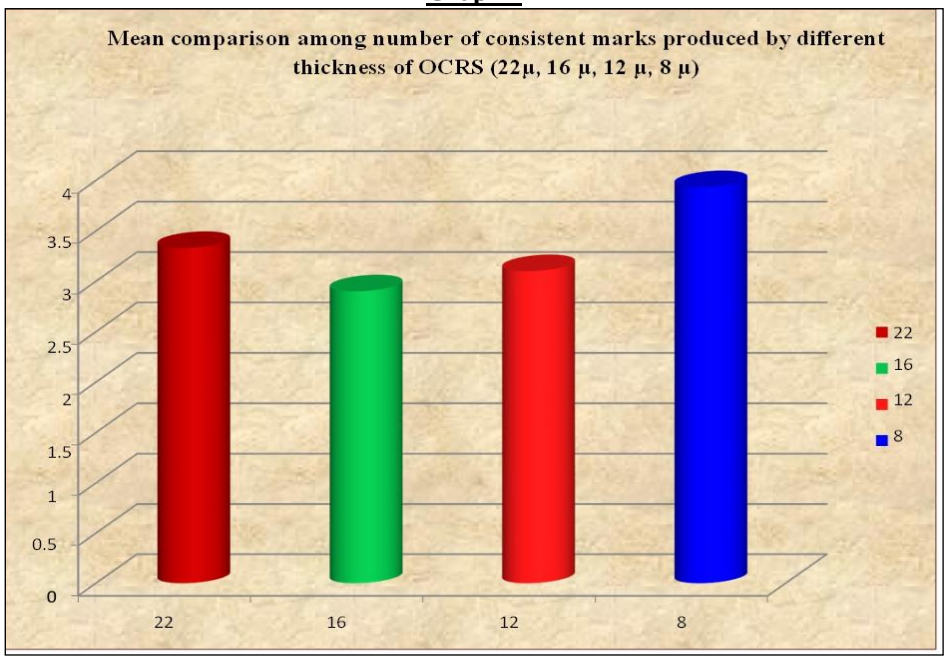

Table 3:- Mean Comparison among Number of Consistent Marks Produced by Different OCRS (22 µ, 16 µ, 12 µ, 8 µ)

(I) GROUP	(J) GROUP	MEAN DIFFERENCE (I-J)	STD. ERROR	SIG
22 µ	**12 µ**	0.43333	0.24817	0.420
	16 µ	0.23333	0.22817	0.883
	8 µ	-0.60000	0.42408	0.064
12 µ	**22 µ**	-0.43333	0.24817	0.420
	16 µ	-0.20000	0.22039	0.929
	8 µ	-1.03333	0.41994	0.125
16 µ	**22 µ**	-0.23333	0.22817	0.883
	12 µ	0.20000	0.22039	0.929
	8 µ	-0.83333	0.40844	0.275
8 µ	**22 µ**	0.60000	0.42408	0.064
	12 µ	1.03333	0.41994	0.125
	16 µ	0.83333	0.40844	0.275

Post hoc analysis
Dependent variable: Mean Multiple comparison
Statistical test: Dunnett T3 test; Statistically significant if P<0.05

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT148

Table 4:- Mean Comparison among Area Marked by Different Thickness of OCRS (22 µ, 16 µ, 12 µ, 8 µ)

	SUM OF SQUARES	DF	MEAN SQUARE	F	SIG
BETWEEN GROUPS	1957.160	3	652.387	3.864	0.014
WITHIN GROUPS	9454.981	56	168.839		
TOTAL	11412.141	59			

Graph 2

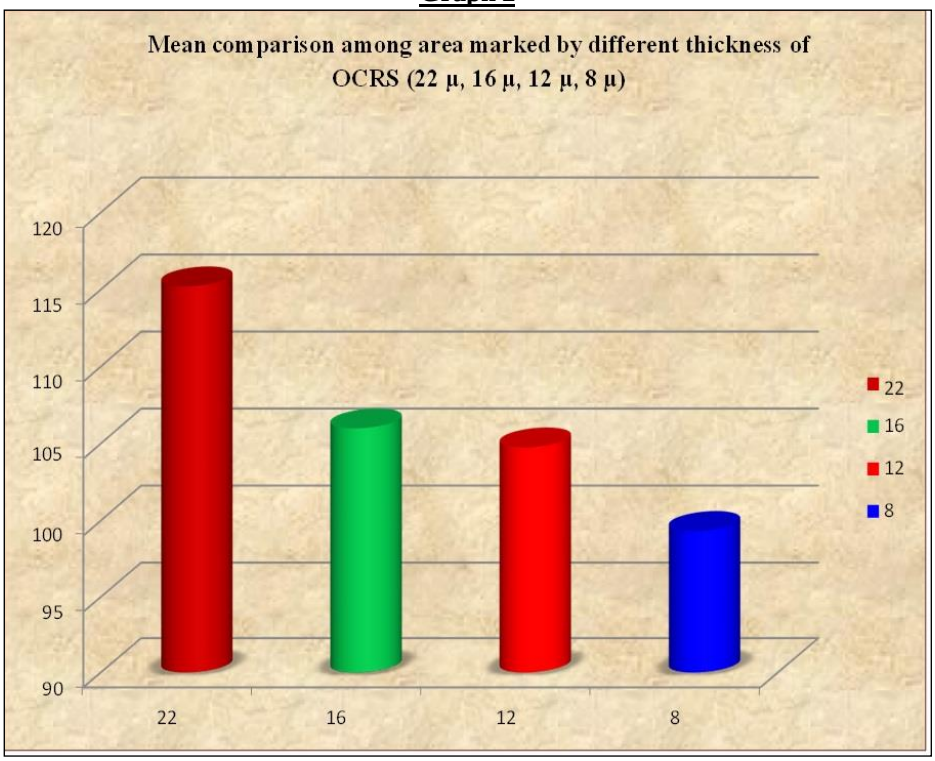

Table 5:- Mean Comparison among the Area Marked by Different OCRS (22 µ, 16 µ, 12 µ, 8 µ)

(I) GROUP	(J) GROUP	MEAN DIFFERENCE (I-J)	STD. ERROR	SIG
22 µ	**12 µ**	10.45514	4.97346	0.230
	16 µ	9.21678	3.56447	0.096
	8 µ	15.88205	5.30546	0.034
12 µ	**22 µ**	-10.45514	4.97346	0.230
	16 µ	-1.23836	4.10801	1.000
	8 µ	5.42691	5.68491	0.912
16 µ	**22 µ**	-9.21678	3.56447	0.096
	12 µ	1.23836	4.10801	1.000
	8 µ	6.66527	4.50426	0.605
8 µ	**22 µ**	-15.88205	5.30546	0.034
	12 µ	-5.42691	5.68491	0.912
	16 µ	-6.66527	4.50426	0.605

V. DISCUSSION

The selection of an appropriate occlusal registration strip enables the dentist to work with precision and provides valuable information on occlusion. The sensitivity and reliability of the techniques used for occlusal analysis depend on the thickness, strength and elasticity, composition and ink substrate, plastic deformation, and frictional characteristics of the recording materials as well as the oral environment and clinician's interpretations.[5] Natural dentition can perceive loads on the occlusal surface, depending on signals from the receptors in the periodontal membrane. This occlusal perception is lost or altered with changes in occlusion due to loss of teeth, pathology, or restorative treatments, which can be restored by prosthetic rehabilitation. Thus, to normalize occlusal sense and restore sensory input from the oral cavity to a level where the comfort of the patient is maintained, even the negligible dimensions of the occlusal discrepancies must

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT148

be attended to. Occlusal interferences must therefore be eliminated through indirect and direct means using articulator-mounted casts in the laboratory and chair-side, respectively.[11,12]

In this study, the state of occlusion was studied indirectly by mounting the casts on a semi- adjustable articulator. The surrounding soft tissue, the flow of saliva, and the general problems in diagnosing occlusal situations, especially in the side segments are severe limitations for accurate intraoral studies of the occlusion. Though, indirect method of studying occlusion is far more time-consuming than the direct intraoral procedure, if all the technical details required to produce the models, transfer and mounting of models on the articulator, and proper individual programming of the articulator are properly carried out, the indirect method of occlusion analysis would be a highly reliable method.[13]

Various evidence in literature point towards the relationship between the mark size and the thickness of occlusal indicators. The most reliable and valid occlusal contact registration strip helps to achieve harmonious occlusion in patients.[14,15] Correlating with the results of this study, a thin occlusal indicator is considered advantageous in that it is well below the perception level of the patients and it locates centric and balancing interferences with high level of precision. Thicker indicators could cause jaw deflection in the process of occlusal contact verification.[16] Paper registration strips are prone to shreds and tears especially when they are wet which is impractical for evaluating occlusion.[17] Hence proper selection of occlusal indicators is essential for the establishment of occlusal harmony and to reduce patient discomfort. Postural variations in the jaw and excursive contacts during specimen collection, subjective definition and sketching of the boundaries of registration marks are the few areas that required precision for accurate interpretation.[18]
Occlusion scans are now becoming more useful in evaluating occlusal contacts. The digital analyser, acting as a force gauge, identifies the contacts, measures the contact force, pressure, and timing sequence. It assists the clinician in occlusion adjustments of prostheses, restorations, and natural teeth. Though this media is regarded as superior, it is expensive and has a learning curve that requires specialist training.[19]

VI. CONCLUSION

Within the limitations of this study, it was found that there exists a relationship between the thickness of an occlusal contact registration strip, the number and the area of the marks registered. The average number of marks produced by the thinnest occlusal contact registration strip used in this study {Articulating foil (8 µ)} was higher when compared to the other strips. Therefore, the thinner the occlusal contact registration strip, the more reliable is the occlusal contact registration. The greatest average area of consistent marks for every stroke applied, was registered by the thickest occlusal contact registration strip {Gnathofilm (16 µ)} and the smallest, by the thinnest occlusal contact registration strip {Articulating foil (8 µ)}. Hence, the thickest occlusal contact registration strips were more valid for marking occlusal contacts.

ACKNOWLEDGMENT

Dr. B Sreeramulu Professor and HOD, Department of Prosthodontics, Government Dental College and Hospital, Hyderabad

Dr. M Githanjali, Assistant Professor, Department of Prosthodontics, Government Dental College and Hospital, Hyderabad

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ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT148

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