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Evaluation and Comparison of Occlusal Contacts Using T-Scan in Maximum Intercuspation and Balanced Occlusion at Different Values of Semi-Adjustable Articulator – An In-Vitro Study

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KEYWORDS

Balanced Occlusion, T-scan, Occlusal Contacts, Occlusal plane template

ABSTRACT:

Introduction The purpose of this study is to evaluate the occlusal contacts using T-scan in maximum intercuspation and balanced occlusion and comparison of the results.

Methods: Edentulous molds are used to pour casts in dental stone. Denture base and occlusal rims were fabricated and then mounted on Hanau wide vue semi-adjustible articulator at different values. In the first group (n=6), teeth arrangement was done in maximum intercuspation and the other group (n=6), had teeth arranged in balanced occlusion. The occlusal contacts of both the groups were checked with T-scan in various mandibular movements and the results were evaluated.

Results: No statistically significant difference was found between both the groups tested.

Conclusions: Within the limitations of the current study, it was seen that there were no statistically significant differences seen in occlusal contacts when a balanced occlusion denture was fabricated using conventional methods to that of using an 8” occlusal plane template. Further in-vivo studies are required to ascertain whether one is superior when compared to the other.

Key Messages: Balanced occlusion is a preferred occlusal scheme for complete denture patients to enhance stability of dentures. However, the occlusal contacts in balanced occlusal scheme has not yet been proven to be superior when compared with conventional methods.

Journal of Chemical Health Risks
www.jchr.org
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1. Introduction

Occlusion is defined as the static relationship between incising and masticating surface of the maxillary and mandibular teeth.[1] A lot of concepts and techniques have been put forward by various authors and researchers to obtain a complete denture occlusion. Over the years, various types of occlusion have been introduced for successful fabrication of complete denture prosthesis.

Balanced occlusion is defined as the bilateral, simultaneous, anterior, and posterior occlusal contact of teeth in centric and eccentric positions.[2] In artificial dentition, a space occurs between the upper and lower posterior teeth especially during excursive movements leading to loss of denture stability. Of all the different occlusal schemes, balanced occlusion is the preferred occlusal scheme due to even distribution of masticatory forces which causes improvement of denture efficiency and stability.[1]

The advantages of occlusal balance are preservation of the stability of complete dentures for the chewing function, and decrease in active loading of supporting tissue and edentulous ridge. The curve of Spee and Wilson must be followed while arranging artificial posterior teeth.[3]

An articulator is a mechanical instrument that represents the temporomandibular joints (TMJ) and jaws, to which maxillary and mandibular casts may be attached to simulate some or all mandibular movements.[4] Fully adjustable articulators are not practical, demand knowledge on equipment and require long chair side time while fabricating complete dentures. On the other hand, non-adjustable articulators are easy to handle but fail to obtain balanced occlusion.[1] Considering the above-mentioned statements, semi-adjustable articulators are easy to handle and allow a full balanced occlusion during mandibular excursions. Semi adjustable articulators is one, which is adjustable in one or more, but not all of the following areas: condylar angle, lateral movement of condyle, incisal and cuspid guidance, and shape of the glenoid fossae and eminintiae.[5] Achieving bilaterally balanced occlusion is time consuming and technique sensitive.[1] These limitations can be encountered when 8" occlusal plane template is used to reduce the time on occlusal adjustments.

The present in-vitro study is conducted to check the efficacy of balanced occlusion achieved through conventional methods and to compare the same with that achieved through the use of an 8'' occlusal plane template using reference points (Frankfort horizontal plane and horizontal occlusal plane) in Hanau Wide vue articulator and compare the occlusal contacts of the same in both centric and eccentric movements using T-scan.

2. Methods

1. Dental stone (Goldstone, Asian Chemicals, Rajkot, India) was poured into silicone molds and allowed to set. **(Figure 1)**

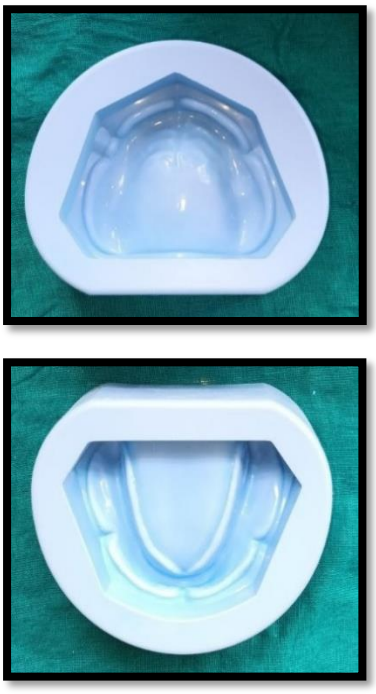

Figure 1. Maxillary and mandibular silicone edentulous molds.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(5), 2483-2496 | ISSN:2251-6727

2. The edentulous casts were removed from the molds thereafter. **(Figure 2)**

Figure 2. Edentulous maxillary and mandibular casts retrieved from silicone molds.

3. A layer of separating medium (Cold mould seal, Dental products of India, Mumbai) was applied onto the cast with the help of camel hairbrush and allowed to dry.

4. Self-cure acrylic resin (DPI RR Cold Cure, Dental products of India, Mumbai) was mixed in a porcelain jar and denture bases were fabricated for all the casts.

5. The bases were then removed and the borders were trimmed using F1 acrylic trimming burs and smoothened with sandpaper grit size 120.

6. Occlusal rims were fabricated using modelling wax (Hindustan Dental Products, Hyderabad) over the denture bases and mounted in semi-adjustable articulator (Hanau Wide vue, Whipmix, Louisville, New York) using the annular notch representing 54 mm below Frankfort horizontal plane as reference. **(Figure 3A,3B)**

Figure 3A. Denture bases and occlusal rims fabricated on maxillary and mandibular edentulous casts. (n=6)

Figure 3B. Denture bases and occlusal rims fabricated on maxillary and mandibular edentulous casts. (n=6)

7. Teeth arrangement (Acryrock, Ruthinium) was done using conventional methods (n=6) and with the use of occlusal plane template (n=6) with the following mentioned readings. **(Figures 4,5) (Table 1)**

Figure 4. Arrangement of teeth using 8'' occlusal plane template.

Journal of Chemical Health Risks
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JCHR (2025) 15(5), 2483-2496 | ISSN:2251-6727

Figure 5. Arrangement of teeth using conventional methods

Table 1: Teeth arrangement values

SL. NO.	Sample Name	Right & Left Condylar Guidance	Right & Left Bennet Angle	Anterio-posterior incisal guidance	Lateral incisal guidance
1.	Sample A (with template)	30	15.75	7	10
2.	Sample B (without template)	30	15.75	7	10
3.	Sample C (with template)	20	14.5	10	10
4.	Sample D (without template)	20	14.5	10	10
5.	Sample E (with template)	15	13.875	5	10
6.	Sample F (without template)	15	13.875	5	10

8. For teeth arrangement using occlusal plane template, the mounted maxillary cast along with the upper occlusal rim was removed from the articulator.

9. Then the upper member locking device was fixed to the upper member and vertical rod was locked to the occlusal template using plate securing nut. **(Figure 6)**

Figure 6. Occlusal plane template attached to the upper member of Hanau Wide vue articulator

10. Template was secured to the upper member locking device using the horizontal lock nut such that the plate touches the anterior plane of mandibular rim and posterior is at the level of the anterior 2/3rd of retromolar pad.

11. The midline of plate should co-incide with the midline of rim. Lower anterior teeth

Journal of Chemical Health Risks
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JCHR (2025) 15(5), 2483-2496 | ISSN:2251-6727

were then arranged such that their incisal edges touch the anterior part of the plate.

12. Now the entire assembly was removed and maxillary anterior teeth arrangement was done with the planned overjet. The anterior curvature of the plate automatically places the incisal edges of lower anterior with a 0.5mm overbite.

13. The maxillary cast and rims were again removed and the occlusal plane template was tightened with screw to the upper member of articulator following which mandibular posterior teeth arrangement was done in such a way that they fall over the crest of ridge and cusps touch the curvature of occlusal template. This gives an antero-posterior and medio-lateral curvature to the lower posterior teeth arrangement. It was reconfirmed at this stage that the line joining the central grooves, line joining the crest of mandibular ridge and the antero-posterior line of the occlusal template coincide or are nearly parallel to each other. **(Figure 7,8)**

Figure 7,8. Arrangement of mandibular teeth using occlusal plane template

14. The occlusal plane template is again removed and the maxillary upper cast along with the occlusal rims were fixed to the upper member. Teeth arrangement was completed for the maxillary posteriors to get the final occlusion. Verify the position of the teeth to achieve balanced occlusion.

15. T-scan sensor (large size) **(Figure 9)** was placed inside the T-scan handle assembly **(Figure 10).** The scanner was connected to computer software and individual tooth were measured for their mesiodistal width with the use of vernier caliper.

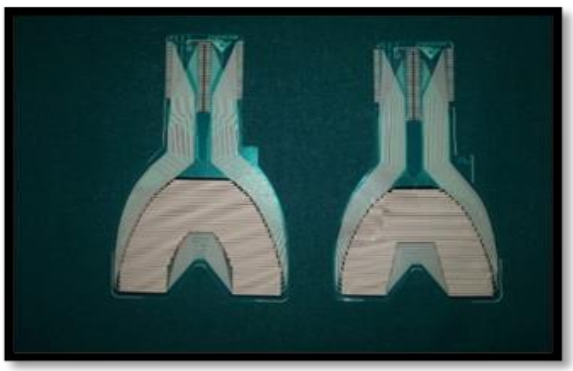

Figure 9. T- scan assembly

Figure 10. T-scan sensor

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JCHR (2025) 15(5), 2483-2496 | ISSN:2251-6727

16. The values were entered in the software with the exclusion of third molars. The articulator was closed in centric occlusion and then the left and right lateral movements were carried out.
17. All the data was collected via the software and the percentage of occlusal contacts were tabulated. **(Figure 11)**

Figure 11. Interpretation of occlusal contacts using T-scan software

Results:

Table 2: Comparison of occlusal contacts (centric, left and right) in 30 with template1 and without template1.

Parameter	Groups	n	Mean	Std. Deviation	p
Centric	**30 with template1**	**14**	6.31	7.37	0.64
	30 without template1	**14**	6.80	8.48	NS
Left	**30 with template1**	**14**	5.75	9.99	0.66
	30 without template1	**14**	7.15	9.88	NS
Right	**30 with template1**	**14**	7.79	12.31	0.81
	30 without template1	**14**	4.92	6.89	NS

Mann-Whitney U test; * Statistically significant; p<0.05; NS- not significant

Table 2 illustrates the comparison of occlusal contacts (centric, left and right) in 30 with template1 and without template1. There is no statistically significant difference between 30 with and without template 1 for centric, left and right occlusal contacts.

Journal of Chemical Health Risks
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JCHR (2025) 15(5), 2483-2496 | ISSN:2251-6727

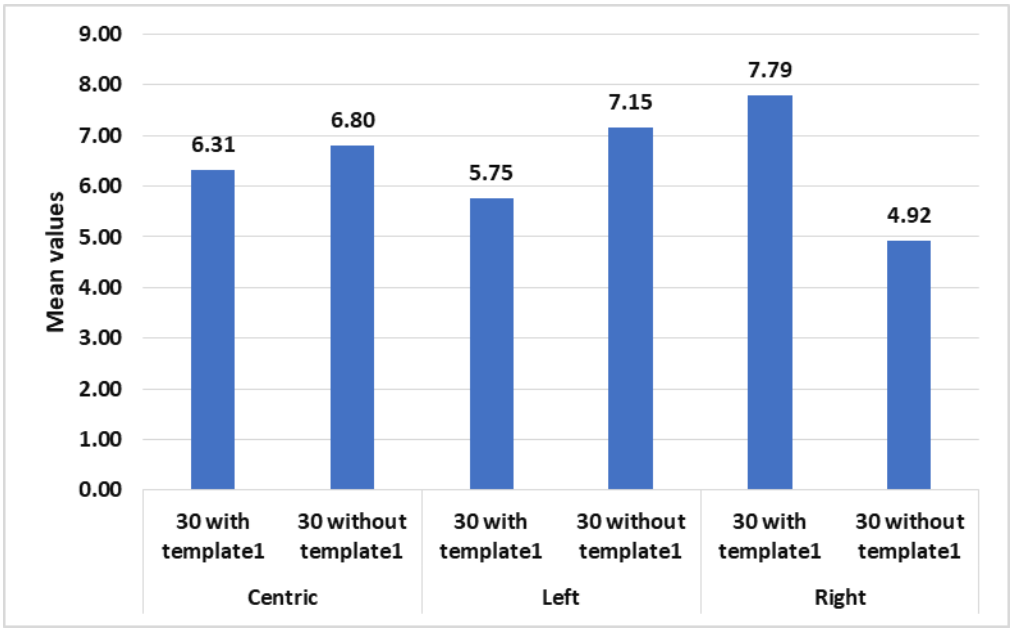

Figure 12: Comparison of occlusal contacts (centric, left and right) in 30 with template1 and without template1.

Table 3: Comparison of occlusal contacts (centric, left and right) in 30 with template2 and without template2.

Parameter	Groups	n	Mean	Std. Deviation	p
Centric	**30 with template2**	**14**	6.28	7.42	0.87
	30 without template2	**14**	8.15	9.53	NS
Left	**30 with template2**	**14**	5.26	10.08	0.40
	30 without template2	**14**	8.33	10.50	NS
Right	**30 with template2**	**14**	7.38	12.55	0.92
	30 without template2	**14**	6.22	8.18	NS
Mann-Whitney U test; * Statistically significant; p<0.05; NS- not significant					

Table 3 illustrates the comparison of occlusal contacts (centric, left and right) in 30 with template2 and without template2. There is no statistically significant difference between 30 with and without template 2 for centric, left and right occlusal contacts.

Journal of Chemical Health Risks
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JCHR (2025) 15(5), 2483-2496 | ISSN:2251-6727

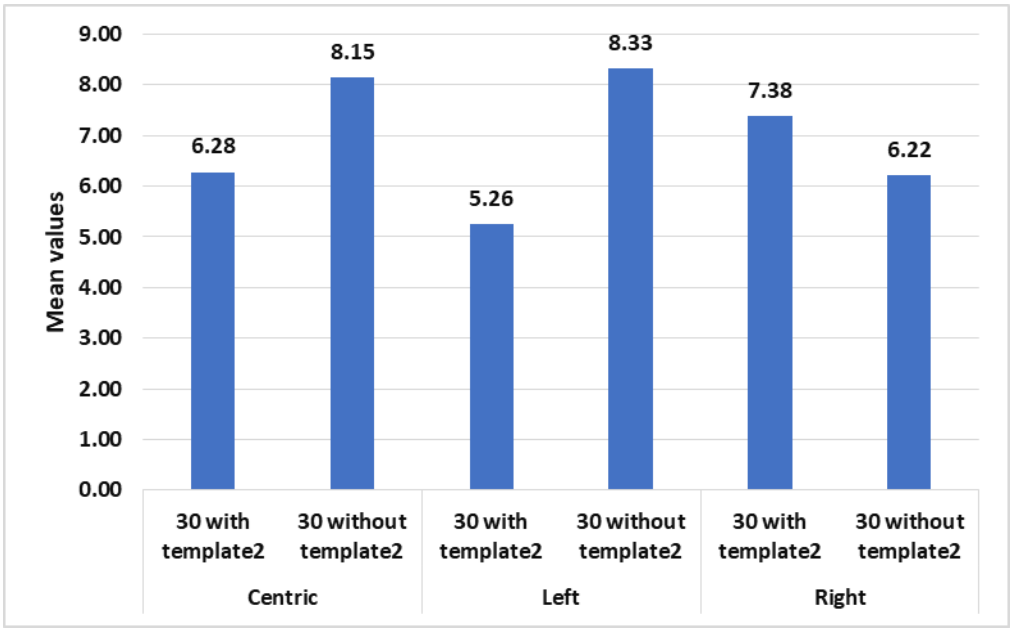

Figure 13: Comparison of occlusal contacts (centric, left and right) in 30 with template2 and without template2.

Table 4: Comparison of occlusal contacts (centric, left and right) in 20 with template1 and without template1.

Parameter	Groups	n	Mean	Std. Deviation	p
Centric	**20 with template1**	**14**	6.14	8.00	0.28
	20 without template1	**14**	6.62	6.12	NS
Left	**20 with template1**	**14**	6.11	8.22	0.42
	20 without template1	**14**	5.21	7.65	NS
Right	**20 with template1**	**14**	6.63	8.30	0.37
	20 without template1	**14**	5.24	9.22	NS

Mann-Whitney U test; * Statistically significant; $p<0.05$; NS- not significant

Table 4 illustrates the comparison of occlusal contacts (centric, left and right) in 20 with template1 and without template1. There is no statistically significant difference between 20 with and without template 1 for centric, left and right occlusal contacts.

Journal of Chemical Health Risks
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JCHR (2025) 15(5), 2483-2496 | ISSN:2251-6727

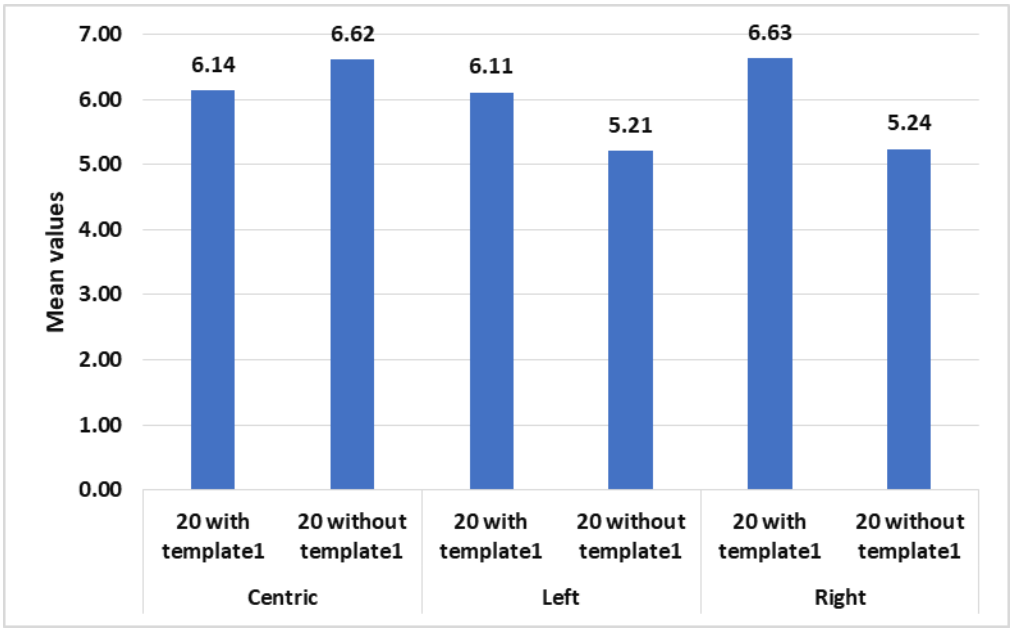

Figure 14: Comparison of occlusal contacts (centric, left and right) in 20 with template1 and without template1.

Table 5: Comparison of occlusal contacts (centric, left and right) in 20 with template2 and without template2.

Parameter	Groups	n	Mean	Std. Deviation	p
Centric	**20 with template2**	**14**	6.62	8.96	0.78 NS
	20 without template2	**14**	7.06	7.43	
Left	**20 with template2**	**14**	6.11	8.85	0.83 NS
	20 without template2	**14**	5.57	5.38	
Right	**20 with template2**	**14**	5.84	6.90	0.75 NS
	20 without template2	**14**	6.05	9.12	

Mann-Whitney U test; * Statistically significant; $p<0.05$; NS- not significant

Table 5 illustrates the comparison of occlusal contacts (centric, left and right) in 20 with template2 and without template2. There is no statistically significant difference between 20 with and without template 2 for centric, left and right occlusal contacts.

Journal of Chemical Health Risks
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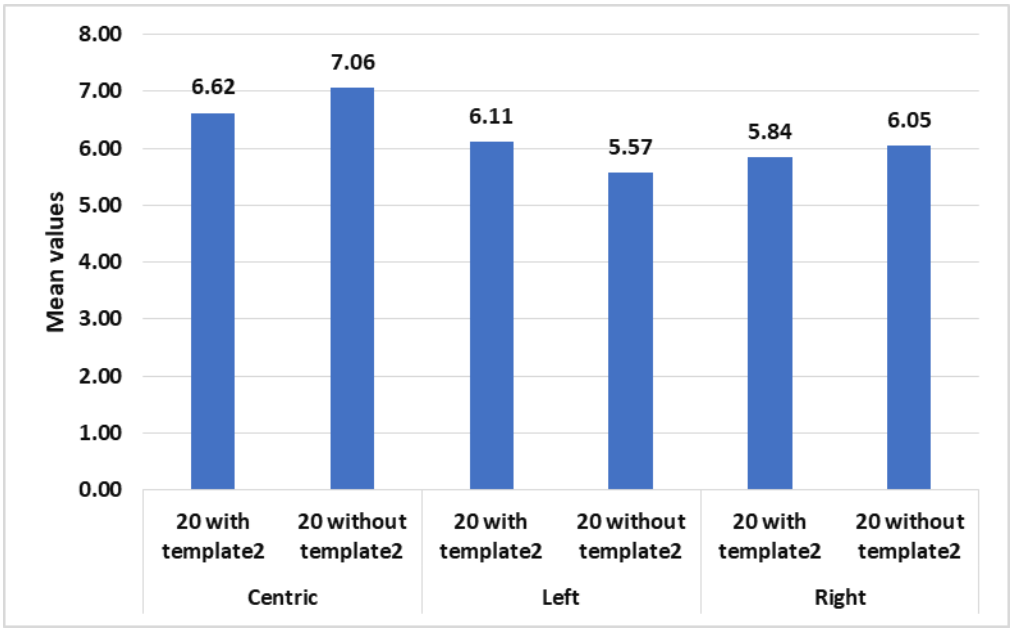

Figure 15: Comparison of occlusal contacts (centric, left and right) in 20 with template2 and without template2.

Table 6: Comparison of occlusal contacts (centric, left and right) in 15 with template1 and without template1.

Parameter	Groups	n	Mean	Std. Deviation	p
Centric	15 with template1	14	6.83	6.75	0.98 NS
	15 without template1	14	6.47	6.66	
Left	15 with template1	14	6.91	7.92	0.67 NS
	15 without template1	14	6.16	9.14	
Right	15 with template1	14	5.99	5.52	0.83 NS
	15 without template1	14	7.15	9.65	

Mann-Whitney U test; * Statistically significant; $p<0.05$; NS- not significant

Table 6 illustrates the comparison of occlusal contacts (centric, left and right) in 15 with template1 and without template1. There is no statistically significant difference between 15 with and without template 1 for centric, left and right occlusal contacts.

Journal of Chemical Health Risks
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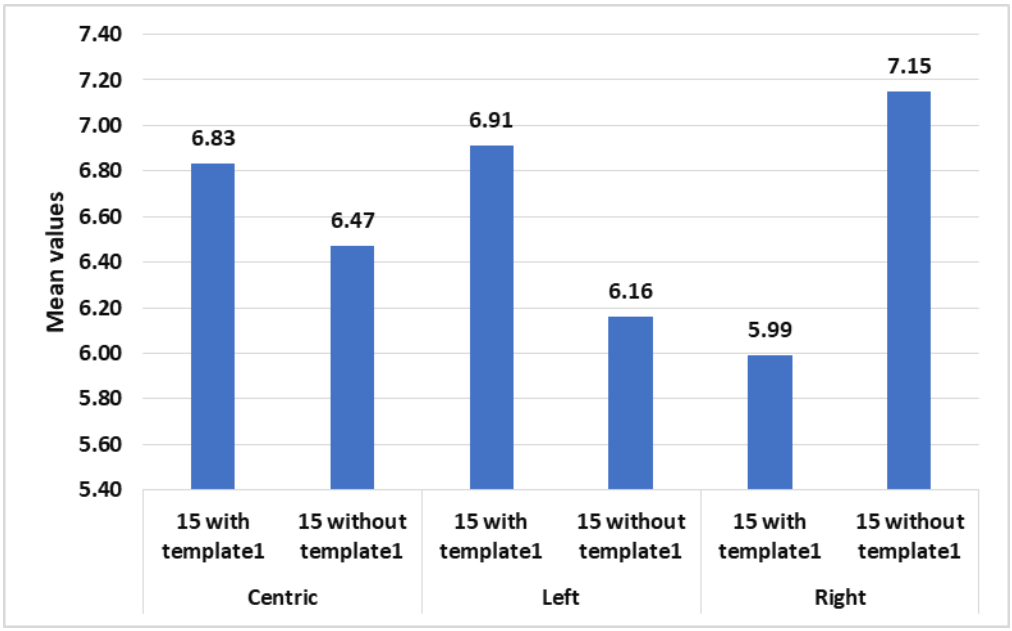

Figure 16: Comparison of occlusal contacts (centric, left and right) in 15 with template1 and without template1.

Table 7: Comparison of occlusal contacts (centric, left and right) in 15 with template2 and without template2.

Parameter	Groups	n	Mean	Std. Deviation	p
Centric	**15 with template2**	**14**	6.79	6.58	0.87
	15 without template2	**14**	7.46	7.69	NS
Left	**15 with template2**	**14**	6.85	7.76	0.96
	15 without template2	**14**	6.54	9.58	NS
Right	**15 with template2**	**14**	6.71	6.08	0.60
	15 without template2	**14**	5.93	9.31	NS
Mann-Whitney U test; * Statistically significant; p<0.05; NS- not significant					

Table 7 illustrates the comparison of occlusal contacts (centric, left and right) in 15 with template2 and without template2. There is no statistically significant difference between 15 with and without template 2 for centric, left and right occlusal contacts.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(5), 2483-2496 | ISSN:2251-6727

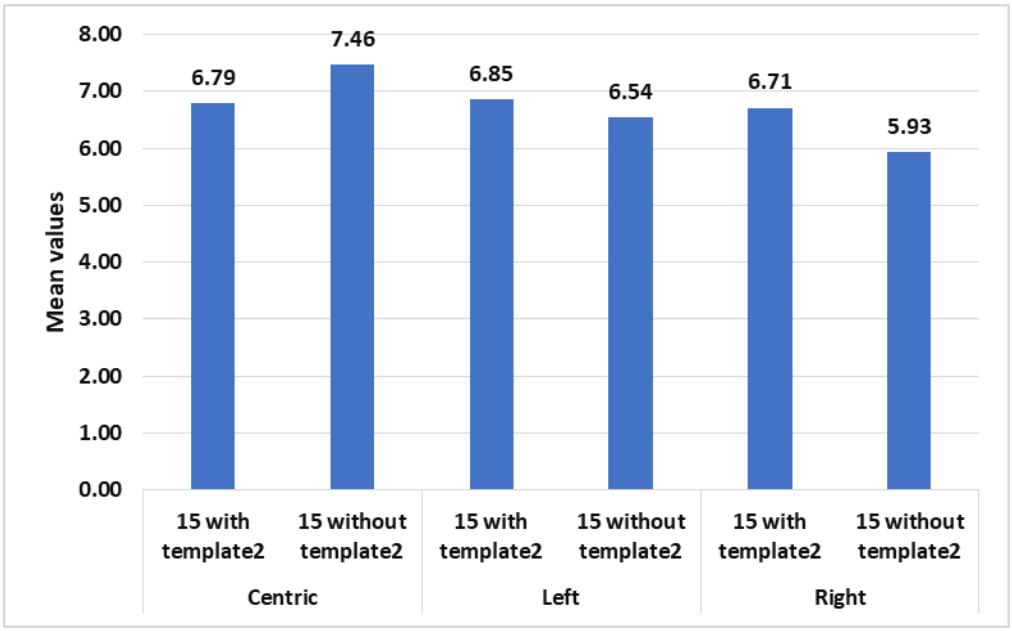

Figure 6: Comparison of occlusal contacts (centric, left and right) in 15 with template2 and without template2.

DISCUSSION:

Complete dentures when constructed using balanced occlusal scheme has shown to enable better force distribution, improve the efficacy of dentures and highly increase the stability of bases.[1] Balanced occlusion can be achieved by establishing three-point occlusal contacts. Since the dawn of dentistry, a lot of materials have been used to check for occlusal contacts.

Evaluation of occlusal contacts can be qualitative or quantitative.[6] Wax, articulating paper and silk strips have been used for qualitatively evaluating occlusal contacts. Articulating papers are frequently used of different width and thickness to mark either a point or surface.[6] However, the disadvantages include its varying thickness and that the markings can be easily ruined by saliva.[7] Silk strips have also been used as materials for evaluating occlusal contacts as they have soft texture and do not produce pseudo markings. However, they are also prone to loss of their marking ability when the stain is dried and can be ruined by saliva.[8] Foils are the thinnest qualitative occlusal registration materials but have been shown to be most accurate.[8] Qualitative methods are not ideal occlusal analyzers due to their static nature, subjective interpretation and limiting factors.[9] Photo-occlusion and T-scan are among the quantitative methods of evaluation of occlusal contacts.[10]

In the photo-occlusion system, a thin photoplastic film layer is placed on the occlusal surface of the teeth; the patient then is asked to occlude on the film layer for 10 to 20 seconds. The film layer is removed from the mouth and inspected under a polariscope light. This technique is reported to be "difficult to apply.[6,10]

The T-Scan system is purported by the manufacturer to be an innovative, computer-aided device that has sensors prepared from conductive ink. In this system, electrical resistance develops with the applied force. When the patient occludes on the sensor, the particles come together in the force applied areas, diminishing the electrical resistance. The u-shaped sensor foil is 60 micron meters thick, consists of an X-Y coordinate system with 1500 sensitive receptor points made of conductive ink, and is subject to elastic deformation.[6]

Journal of Chemical Health Risks

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JCHR (2025) 15(5), 2483-2496 | ISSN:2251-6727

The T-Scan allows the quantification of occlusal contact data by registering parameters such as bite length, as well as the timing and force of tooth contact. The system components include a sensor and support, a handle assembly, the system unit, computer software and a printer. The sensor is the key component. When the patient bites on the sensor, the resultant change in electric resistance is converted into an image on the screen. The programme can be operated on two modes; time analysis and force analysis. The former provides information on the location and timing of contacts displaying on the screen with the first, second and third or more contacts in different colours. The latter shows the location of contacts and their relative force in five different shades of colour. Within the force analysis mode, two sub modes can be selected, namely the 'instantaneous' which records contacts at specific mandibular positions and the 'sequential' which analyses the contact throughout mandibular movement.[11]

The sensitivity of different brands and thicknesses of articulating papers, foils, and silk strips used in qualitative methods were compared with the T-Scan occlusal analysis system and it was found out that repeated usage decreased the number of occlusal contacts for all. Also, the occlusal contacts obtained on dry teeth were more as compared to a wet environment. However, the accuracy of quantitative method far surpassed than that of the qualitative method.[6]

So, in this present study T-scan has been used to check the occlusal contacts. Their results, showed that there is no significant difference between conventional method and using 8 inch occlusal plane template method.

Kumar et al., conducted an in-vivo study, they compared two techniques in achieving balanced occlusion in complete dentures. In Group I, they used conventional techniques to fabricate dentures with balanced occlusion using face bow and semi-adjustable articulator while in Group II, the casts were mounted on articulator based on average values. The arrangement was done according to the Biofunctional prosthetic system with help of a two dimensional template. When compared, it was seen that Group B presented higher number of occlusal contacts when compared to Group A.[1] However, in the present study, the number of occlusal contacts were similar for conventional methods and that of using the occlusal plane template.

CONCLUSION:

In our study, the occlusal contacts obtained from arranging artificial teeth in balanced occlusion using both techniques did not have any significant difference. It has been analyzed that using 8-inch occlusal plane template was time consuming and effective when compared to conventional method. Further in-vivo study is required to recheck whether 8'' occlusal plane template provides better occlusal contacts when compared with conventional method and evaluated with T-scan in an oral environment.

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