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A Comparative Evaluation of Different Impression Techniques for Single Tooth Implant Placement Using Different Impression Materials to Check the Accuracy of Master Cast for Passive Fit of Prosthesis: *An In Vitro Study*

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KEYWORDS

Closed & Open tray copings, Dimensional accuracy

ABSTRACT:

Introduction: The field of modern dentistry has been transformed by the addition of implant prostheses to traditional treatment techniques, which is regarded as a turning point in the development of clinical practises in daily life. One of the pillars of appropriate prosthetic reconstruction continues to be adequate impression procedures. Therefore, this study was done to compare & evaluate two impression techniques, two different impression materials & two types of impression copings.

Methods: A dentulous resin master model with implant in right mandibular first molar was placed. Samples were obtained from both impression materials using two impression techniques and two types of impression copings. The samples were grouped into 8 groups with 13 samples in each group. 3 Points (A, B & C) & 2 Lines (B-marking & C-marking) were drawn on resin model & resultant casts & were used to assess the dimensional accuracy, after measuring with Travelling microscope and Digital Vernier Calliper.

Results: B marking in group C showed highest mean of **1.9769 ± 0.05,** Group C showed highest mean of **36.2869 ± 0.01,** C marking in group C showed highest mean of **4.9262 ± 0.02**, C marking in group C showed highest mean of **41.0469 ± 0.05** interpreting better precision amongst other groups.

Conclusions: **S**tatistically significant differences were not found in the accuracy of master casts using two impression techniques & effect of sandblasting was found statistically significant on external surface of impression copings using two impression techniques.

1. Introduction

Impression making is one of the paramount aspects in implant dentistry. For an aesthetically & functionally acceptable prosthesis, an ideal impression is the backbone. The type of impression material utilized, the implant impression technique employed, the implant angulation, etc. are some of the variables responsible for producing an accurate implant master cast. Hence, having a complete awareness of the factors necessary for a successful treatment outcome is the first step to success.

The use of impression tactics seems to be entwined with fad, fallacy, philosophy, fact and our minds race to make the best decision[1]. Often the choice of impression materials and the technique to be used depends on the subjective choice of the operator based on personal

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preferences and past experience with any particular material.

Any flaws in impression making will inevitably result in laboratory errors, leading in a lack of precision and misfitting of prostheses. It is of great importance, that these inaccuracies are minimized at this stage, otherwise they will be possibly compounded later on. Environmental conditions and the type of tissue dictate the choice of materials, quality of the impression, and quality of the cast.[2,3,4]

The present in-vitro study was aimed at comparing & evaluating different impression techniques for single tooth implant placement using two different impression materials to check the accuracy of master cast for passive fit of prosthesis.

2. Materials & Methods

1. Fabrication of master model

A dentulous clear heat cure acrylic (DPI RR Heat Cure) resin master model was fabricated. An endosteal implant (3.75*10 mm, Alpha Bio Tec.) was placed in right mandibular first molar edentulous area to simulate a clinical situation by creating a hole. The measurements of standard dimensions of the master model (Fig I) were made prior to fabrication of die stone casts.

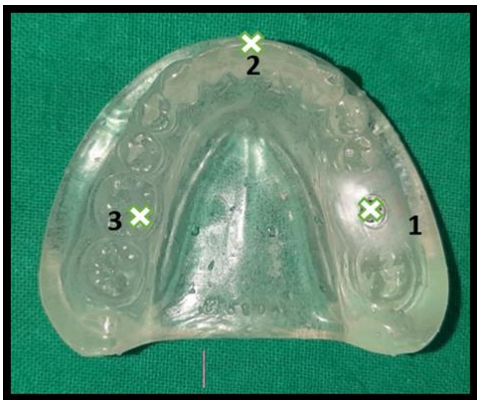

Fig I: Reference Points marked on Master Model

A] Three reference points were marked for measurement -

- Point 1- Centre of the Implant placed
- Point 2- Mesiolingual cusp of the left first molar from the centre of implant
- Point 3- Mesial tip of the central incisors from the centre of implant

B] Two lines were drawn to measure the linear dimensional accuracy of the die stone casts.

i) Point 1 to Point 2 (Referred to as B-marking)

a) Digital Vernier Calliper value- 36.28mm

b) Travelling Microscope value- 1.982mm

ii) Point 1 to Point 3 (Referred to as C-marking)

a) Digital Vernier Calliper value- 41mm

b) Travelling Microscope value- 4.931mm

C] Instruments used to measure the accuracy in this study were

i)Digital Vernier Calliper (Insize, 150mm/ 6Inch, 1112-150) (Fig II)

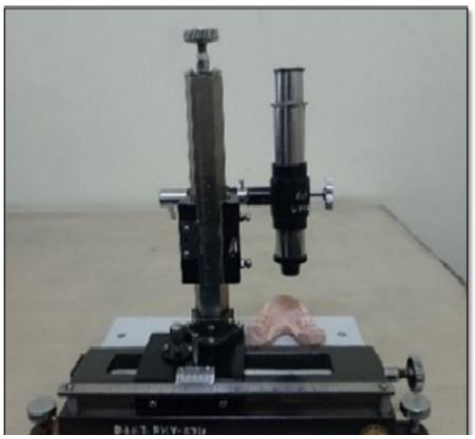

Fig II: Travelling Microscope

ii) Travelling Microscope (Monarch Scientific Industries, MASWO, 10X, ISO 9001:2015) (Fig III)

Fig III: Digital Vernier Calliper

Journal of Chemical Health Risks

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JCHR (2025) 15(2), 233-240 | ISSN:2251-6727

2. Fabrication of custom tray

On the master model a 4 mm thick wax spacer was adapted with tissue stops (2*2 mm) on right first mandibular molar, mesial tip of central incisors & left first mandibular molar equidistant to each other. Self–cure acrylic resin was used to fabricate custom trays of standardized size & thickness for impression making. A custom tray with 2 mm thickness was fabricated. This custom tray was trimmed, polished & flasked. Following this, self-cure acrylic resin was mixed according to the manufacturer's instructions and packed into this mould. After the packed self-cure was set, the flask was opened and the tray was removed. Six vent holes were drilled (canine & second premolar, second molar areas) for the escape of excess material & handle of 3*8*11 mm dimensions were adapted in every individual trays. These custom trays were divided into two groups i.e. closed trays (Fig IV) & open trays (Fig V). The trays used for open tray impression technique group had window created in the right first molar region prior to impression making to allow access for impression coping.

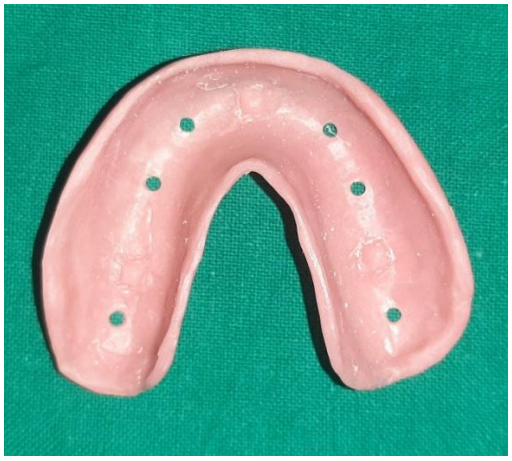

Fig IV: Closed Impression Trays

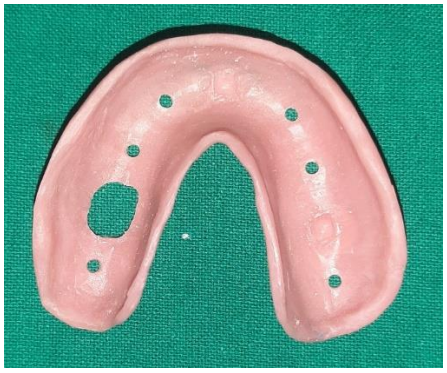

Fig V: Open Impression Trays

3. Modification of impression copings

In this study, the open & closed tray impression copings were sandblasted prior to impression making in order to enhance the accuracy of die stone casts, as per used in Groups B, D, F, H. These sandblasted impression copings were referred as modified copings (Fig VI) & the non-sandblasted impression copings which were not sandblasted were referred as non-modified copings (Fig VII). The external surface of these copings was roughened using 100µm aluminium oxide particles at a pressure of 100psi in a sandblaster. These modified impression copings were used with two different impression materials & two different impression techniques.

Fig VI: Modified Impression Copings

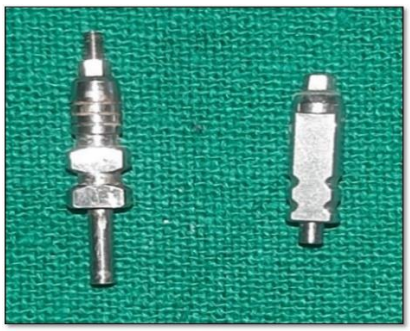

Fig VII: Non-Modified Impression Copings

4. Impression making

Two different elastomeric impression materials viz Addition Silicone and Polyether and two different types of impression copings viz modified and non-modified copings were used for making the impression of master model.

Open tray technique - Tray adhesive was applied on the custom trays prior to impression making and was

Journal of Chemical Health Risks

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JCHR (2025) 15(2), 233-240 | ISSN:2251-6727

allowed to dry for 30 seconds. The impression coping was screwed onto the implant. During impression making, first putty consistency Addition silicone material was mixed according to the manufacturer's instructions and loaded on the tray. Simultaneously the light body Addition Silicone impression material was meticulously syringed around the non-sandblasted impression coping on the model and the impression was made. The tray was held with light pressure to ensure complete seating & the excess material was allowed to flow from the vent holes. Before removal of the impression from the master model, the impression coping was unscrewed and was picked-up along with the impression. Similar procedure was followed for all 3 groups i.e Groups A, B, E, F.

Closed tray technique - A custom tray was fabricated with sufficient relief around the coping. Above mentioned steps were repeated for impression making till the impression material had set. After material had set, the impression was separated removed from the master model with the impression coping tightened onto the master model. The impression coping was then unscrewed and manually placed back into the impression. Similar procedure was followed for all 3 groups i.e. C, D, G, H.

The tray was held in position on master model to ensure that the impression material was completely set. A total of 52 impressions were made for each Addition Silicone & Polyether respectively. (Fig VIII, IX)

Fig VIII: Closed Tray Addition Silicone Impression

Fig IX: Closed Tray Polyether Impression

3. Sample Size Calculation

The sample size was calculated using the G*power version 3.1.9.4. Software. The total sample size was calculated to be 104 for 8 groups with each group the sample being 13 (i.e. 13 x 8 = 104).

4. Grouping of samples

8 groups equally included 13 impressions. The 8 groups labelled as A to H represented: -

Group A- Die stone casts obtained from Addition Silicone material using Open tray technique with Non-modified coping

Group B- Die stone casts obtained from Addition Silicone material using Open tray technique with Modified coping

Group C- Die stone casts obtained from Addition Silicone material using Closed tray technique with Non-modified coping

Group D- Die stone casts obtained from Addition Silicone material using Closed tray technique with Modified coping

Group E- Die stone casts obtained from Polyether material using Open tray technique with Non-modified coping

Group F- Die stone casts obtained from Polyether material using Open tray technique with Modified coping

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(2), 233-240 | ISSN:2251-6727

Group G- Die stone casts obtained from Polyether material using Closed tray technique with Non-modified coping

Group H- Die stone casts obtained from Polyether material using Closed tray technique with Modified coping

5. Die stone casts

1 hour after each impression had set, it was poured with high strength die stone (Type IV). Laboratory analogs were screwed onto the impression copings prior to pouring of impressions. The die stone was mixed according to the manufacturer's instructions, the mixture was hand spatulated with a straight end stiff blade spatula for 10 seconds followed by mixing under vacuum for 60 seconds in vacuum mixer. The impressions were poured while using a model vibrator. It was allowed to set for a minimum of 1 hour before being separated from impression. After retrieval of casts, excess was trimmed using cast trimmer.(Fig X) The same process was followed for other groups.

6. Measurement of Die Stone Cast Accuracy

To measure the linear dimensional accuracy of die stone casts two lines were drawn. The distance between these points were measured 3 times & mean value was considered as final value. The lines measured were i) B-marking (Point 1 to Point 2) & ii) C-marking (Point 1 to Point 3) with a Travelling Microscope (Fig II) which was capable of measuring upto 0.001 mm & with a Digital Vernier Calliper (Fig III) upto 0.01 mm. The tube of microscope could travel both horizontally & vertically so that it could be made parallel to the table top for accurate measurements (Fig X, XI).

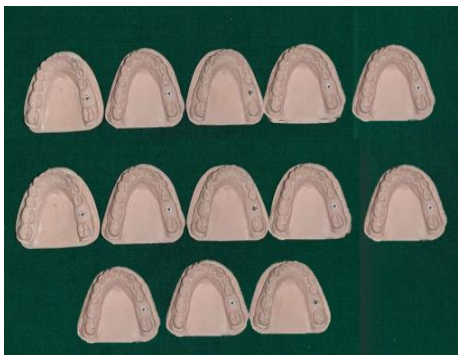

Fig X: Die Stone Master Casts Representing Group A

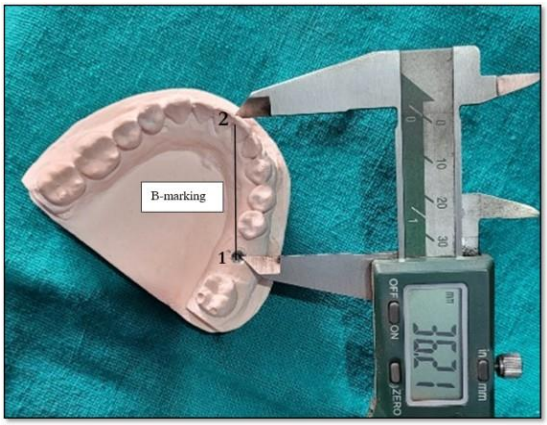

Fig XI: Digital Vernier Calliper Measurement of B-Marking using

Fig XII: Measurement of C-Marking using Digital Vernier Calliper

Each dimension s on the master model was measured 3 times and an average was taken.

The procedure was repeated for all die stone casts i.e. 104 die stone casts. The results were compared with those of the master model. All the values of different measurement of die stone casts obtained from two elastomeric impression materials & two different types of impression techniques were recorded & subjected to statistical analysis.

7. Results

For assessing the dimensional accuracy of die stone casts, they were measured with Travelling microscope and Digital Vernier Calliper. The values were collected, tabulated and stored in a computer using Microsoft Excel. The data was subjected to statistical analysis and results were derived and interpreted. One-way ANOVA test was used for comparing dimensional accuracy of

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JCHR (2025) 15(2), 233-240 | ISSN:2251-6727

two techniques and two materials. Various tables and graphs were tabulated and discussed from Table 1 to 5 and Graph 1 to 5 showing the descriptive statistical analysis.

In Table 1, B marking in group F showed highest mean with SD of **1.9769 ± 0.05;** In Table 2, B marking in group F showed highest mean with SD of **36.2869 ± 0.01** but was **not statistically significant (0.226)** for Digital Vernier Calliper**;** In Table 3, C marking in group F showed highest mean with SD of **4.9262 ± 0.02;** In Table 4, C marking in group F showed highest mean with SD of **41.0469 ± 0.05**. Thus interpreting that group F showed better precision amongst other groups using one-way ANOVA test with p value set at < 0.05 for statistical significance. Table 5 showed values of Group F of all groups & their Comparison between 2 Interventions.

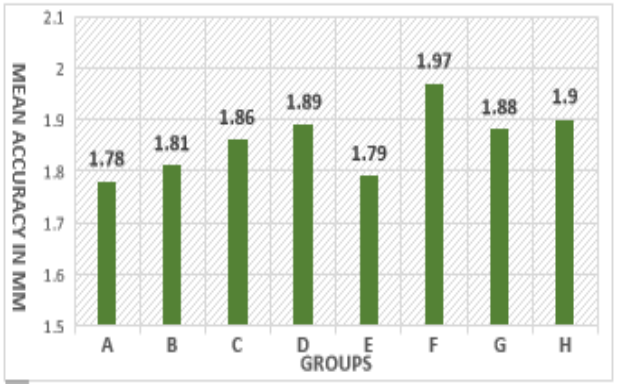


Fig XIII: Graph 1 Showing descriptive Distribution of B markings for Travelling Microscope.

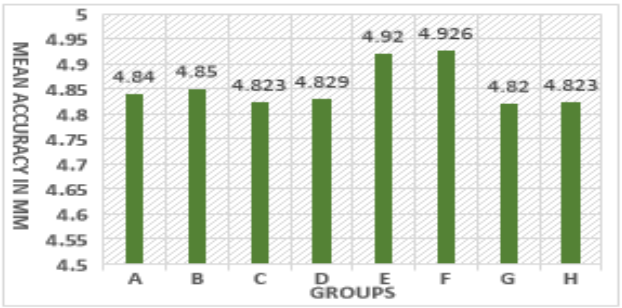


Fig XIV: Graph 2 Showing Descriptive Distribution of C markings for Travelling Microscope

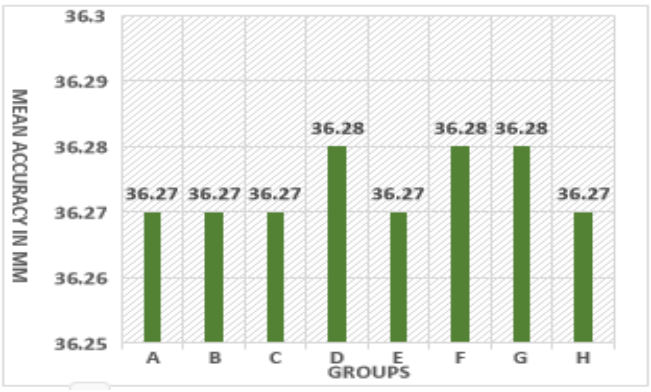
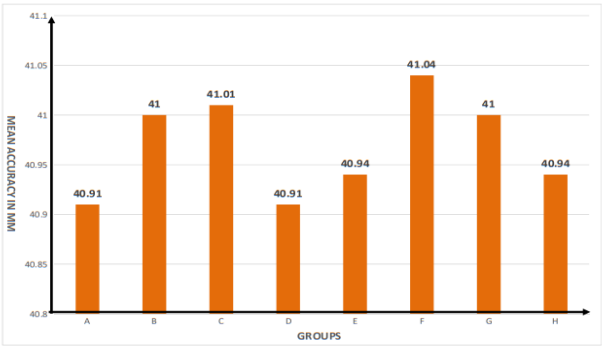


Fig XV: Graph 3 Showing Descriptive Distribution of B markings for Digital Vernier Calliper



Graph 4 – Descriptive distribution of C markings for Digital Vernier Caliper

Fig XVI: Graph 4 Showing Descriptive Distribution of C markings for Digital Vernier Calliper

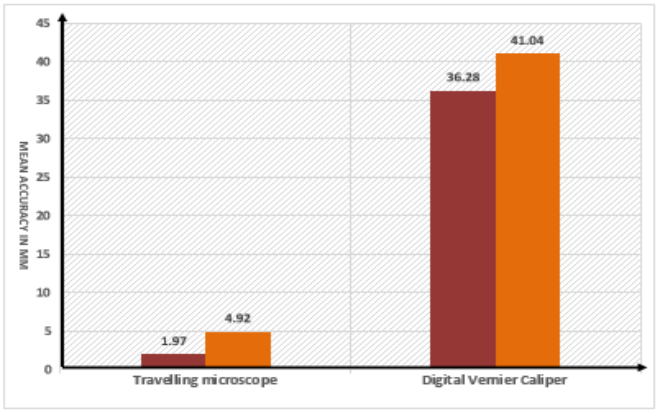


Fig XVII: Graph 5 Showing Comparison between 2 interventions using one-way ANOVA test

Journal of Chemical Health Risks

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JCHR (2025) 15(2), 233-240 | ISSN:2251-6727

8. Discussion

The field of modern dentistry has been transformed by the addition of implant prostheses to traditional treatment techniques, which is regarded as a turning point in the development of clinical practises in daily life. One of the pillars of appropriate prosthetic reconstruction continues to be adequate impression procedures. Any error that is overlooked at this stage will only have more severe implications later. Consequently, the first step to success is having a thorough understanding of the variables involved for a good treatment outcome.

The values of Tables 1 to 4 were plotted in Graph 1 to 5 showing the descriptive statistical analysis of B marking & C marking with Travelling Microscope & Digital Vernier Calliper respectively. The results of the forgoing study were in accordance with various articles published in the literature.[4,5,6]

Table 1 values depicted that Polyether impression material yielded more accurate casts as compared to Addition silicone & the results were statistically significant & were plotted in Graph 1. These findings were in accordance with Kankane S et al[7] who stated in their study That polyether impression material is more exact when used directly, with a group mean cast error of 0.045mm, than when used indirectly, with a group mean cast error of 0.087 mm.

B marking Groups	Mean ± SD	p value (<0.05)
A	36.2723 ± 0.00725	
B	36.2738 ± 0.00870	
C	36.2785 ± 0.00555	
D	36.2846 ± 0.03205	
E	36.2785 ± 0.00555	
F	36.2869 ± 0.01316	*0.226
G	36.2838 ± 0.01193	
H	36.2777 ± 0.02279	

Table 1: Descriptive distribution of B markings for Travelling Microscope

Table 2 values depicted that die stone casts obtained from open & close tray technique yielded similar results but these results were not statistically significant & were plotted in Graph 2. These findings were consistent with those of Galluci G et al[9], who evaluated the accuracy outcomes of open and closed tray implant impressions for partially edentulous patients in their study. According to their findings, there were no statistical differences between open and closed tray impression techniques in partially edentulous individuals with implants that were less than 10 degrees angular.

C marking Groups	Mean ± SD	p value (<0.05)
A	4.8462 ± 0.08771	
B	4.8500 ± 0.08416	
C	4.8238 ± 0.00506	
D	4.8292 ± 0.00641	
E	4.9208 ± 0.02139	*0.000
F	4.9262 ± 0.02181	
G	4.8292 ± 0.00641	
H	4.8308 ± 0.00641	

Table 2: Descriptive distribution of C markings for Travelling Microscope

Table 3 values depicted that die stone casts obtained from Polyether impression material yielded more accurate casts as compared to Addition silicone material & were plotted in Graph 3. The findings of the preceding investigation were consistent with Ciesco et al[11] who did a study comparing five impression materials which included two polysulfides (one lead-cure and one non-lead cure), two silicones (one condensation polymerization and one addition polymerization), and one polyether. When compared to the other impression materials, they concluded that the Polyether material consistently produced superior outcomes, with or without a custom tray.

Journal of Chemical Health Risks

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JCHR (2025) 15(2), 233-240 | ISSN:2251-6727

B marking Groups	Mean ± SD	p value (<0.05)
A	1.7846 ± 0.09216	*0.000
B	1.8192 ± 0.03353	
C	1.8685 ± 0.04793	
D	1.8985 ± 0.08989	
E	1.7938 ± 0.00768	
F	1.9769 ± 0.05073	
G	1.8808 ± 0.00862	
H	1.9023 ± 0.00725	

Table 3: Descriptive distribution of B markings for Digital Vernier Calliper

Table 4 values were plotted in Graph 4 which represented the Descriptive distribution of B marking for Digital Vernier Caliper where Group F had maximum mean value interpreting better precision than other groups. Vigolo P et al[8] also stated in their study that, on the accuracy of the master casts obtained using roughened and adhesive-coated impression copings for obtaining a master cast that, on the reference resin model the improved copings demonstrated much less rotating movement of the hexagon head of the implant.

C marking Groups	Mean ± SD	p value (<0.05)
A	40.9185 ± 0.04670	*0.000
B	41.0077 ± 0.00725	
C	41.0108 ± 0.01038	
D	40.9185 ± 0.04670	
E	40.9462 ± 0.03798	
F	41.0469 ± 0.04571	
G	41.0031 ± 0.00480	
H	40.9462 ± 0.03798	

Table 4: Descriptive distribution of C markings for Digital Vernier Calliper

Table 5 showed the Comparison between 2 Interventions using one-way ANOVA test. The values of Group F of all tables were depicted and plotted in Graph 5.

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