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Original Research Article

Comparative evaluation of dimensional accuracy of irreversible hydrocolloid impression material using different types of tray

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ABSTRACT

Introduction: Irreversible hydrocolloid impression materials are widely used in dentistry due to their low cost and ease of use. To ensure accurate models, it is essential to determine the optimal tray design and material. This article compares the dimensional accuracy of irreversible hydrocolloid impressions using four different types.**Aim & Objectives:** To evaluate the dimensional accuracy of irreversible hydrocolloid impression materials with four different impression tray types, and to identify the optimal tray design and material for producing precise dental models.**Materials and Methods:** Dentulous maxillary model was taken for the study. The canines and first molars of the model were replaced with metal dies on either side. The molar dies were made with two cusp one buccal and palatal. The trays used in the study were Perforated Rimlock tray, perforated stock metal tray, perforated stock plastic tray, perforated custom tray (self-cure acrylic resin). All the above mentioned trays were modified to get the exact same orientation of the trays every time for making the impressions. Therefore two extra handles are attached laterally on each tray. A hole was made in each handle for the orientation of the tray on tray positioning device. To position the each tray on the model in same orientation was difficult so to overcome this problem a tray positioning device was designed.**Results:** The antero-posterior distances (A-B and C-D) and cross arch distances (B-C and D-A) in all the groups were compared and found that the dimensional changes in all groups were insignificant except the Perforated stock plastic tray i.e. groups III, which showed highly significant differences.**Conclusions:** The proper impression material and tray combination is crucial and very important to achieve desirable results in terms of dimensional accuracy and the quality of the impressions. Thus the results of the present study should be helpful to the dental practitioners in selection of the impression tray before making impressions with the irreversible hydrocolloid impression material.This is an Open Access (OA) journal, and articles are distributed under the terms of the [Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License](https://creativecommons.org/licenses/by-nc-sa/4.0/), which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.For reprints contact: reprint@ipinnovative.com

1. Introduction

Irreversible hydrocolloid impression materials are regularly used in the dental office. Used to produce stone casts in almost every field of dentistry, they are popular, primarily, because of their low cost and ease of use compared to

other impression materials, and it is important to know whether impressions made by irreversible hydrocolloid are dimensionally accurate to get the more accurate models.¹ Which tray design and tray material should be preferred to use with irreversible hydrocolloid impression material to improve the accuracy and quality of impression.² Thus, in this article the dimensional accuracy of the irreversible hydrocolloid impression material was compared using four

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different types of impression.

2. Materials and Methods

Dentulous maxillary model was taken for the study. The canines and first molars of the model were replaced with metal dies on either side.³ The molar dies were made with two cusp one buccal and palatal. (Figure 1) The trays used in the study were Perforated Rimlock tray, perforated stock metal tray, perforated stock plastic tray, perforated custom tray (self-cure acrylic resin).(Figure 2)



Figure 1: Dentulous maxillary model



Figure 2: Modified trays with two extra handles

All the above mentioned trays were modified to get the exact same orientation of the trays every time for making the impressions. Therefore two extra handles are attached laterally on each tray. A hole was made in each handle for the orientation of the tray on tray positioning device.⁴ To position the each tray on the model in same orientation was difficult so to overcome this problem a tray positioning device was designed.(Figure 3)



Figure 3: Tray positioning device



Figure 4: Orientation of the trays on the device

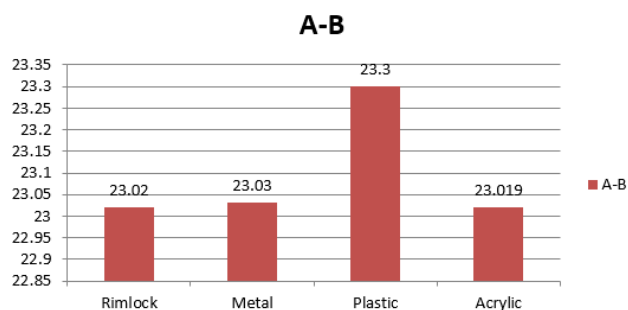


Figure 5: Application of tray adhesive

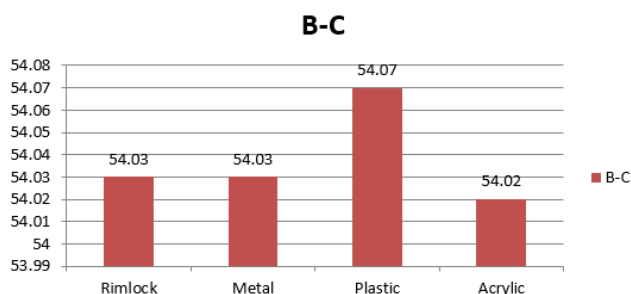
Table 1: ANOVA test to compare dimensional accuracy between trays with adhesive.

Distance	F-value	p-value	1-2	1-3	1-4	2-3	2-4	3-4
A-B	147.53	0.0000	1.00	0.000	1.00	0.000	1.00	0.000
B-C	58.93	0.000	0.029	0.000	0.039	0.000	1.000	0.000
C-D	15.92	0.0000	1.000	0.000	1.000	0.000	1.000	0.000
D-A	157.43	0.0000	1.000	0.000	1.000	0.000	1.00	0.000

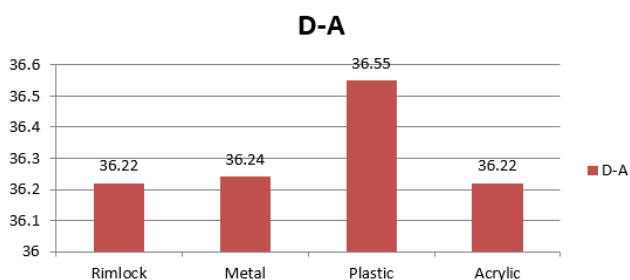
P<0.05 significant, p<0.001, Highly significant p>0.05 Not significant



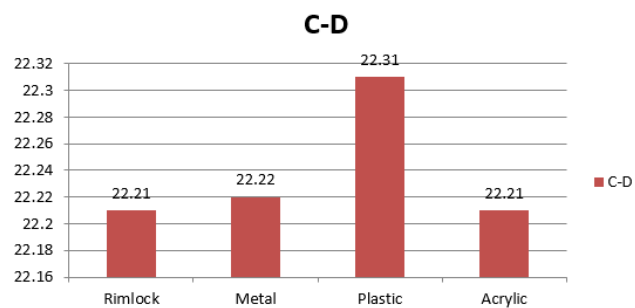
Graph 1: Antero-posterior (left side) distances in trays with application of the tray adhesive. (Distances in mm)



Graph 2: Cross arch (Posterior) distances in trays with application of the tray adhesive



Graph 3: Antero-posterior (Right side) distances in trays with application of tray the adhesive. (Distances in mm)



Graph 4: Cross arch (Anterior) distances in trays with application of the tray adhesive

Before making an impression the impression tray was first oriented and checked on the tray positioning device.^{4,5}(Figures 4 and 5) The measured amount of distilled water was taken in clean dry rubber bowl and then pre weighted packet of the alginate was poured into the rubber bowl with water powder ratio 1:2.6 (according to manufacturer).Then the material was loaded on the tray.

The loaded impression tray was then positioned on the device to make the impression, the impression was seated and held 1 minute beyond the setting time of the material, and then impression was retrieved from the device and checked for any irregularity or voids in the impression ,if acceptable ,the impressions were poured immediately with type IV dental stone. Same method was used to make impressions with all four trays. The cast were removed from impression after one hour. The models were examined if acceptable then marked for the future measurements.

Four types of tray were used to make impressions, 20 impressions were made using each tray. Total 80 models divided into 4 groups.

- Group I: Perforated Rimlock tray
- Group II Perforated stock metal tray
- Group III Perforated stock plastic tray
- Group IV Perforated custom tray (self-cure acrylic resin)

The measurements of the models were taken 24 hours after cast removal from the impressions. The measurements were taken with the help of travelling microscope (Pico India Co.). As four reference points are taken on canines and first molars on the model named as, A (cusp tip of left canine), B(buccal cusp tip of left first molar), C(buccal cusp tip of right first molar), D(cusp tip of right

canine). Four measurements were taken of each model, two antero-posterior and two cross arch. The readings between four reference points are A-B = Antero-posterior distance left side (canine to first molar), B-C = Cross arch distance posterior (first molar to first molar), C-D = Antero-posterior distance right side (canine to first molar) and D-A = Cross arch distance anterior (canine to canine).

The measurements of the original model were A-B = 23.01mm, B-C = 54.01mm, C-D = 22.21mm, D-A = 36.20mm.

3. Results

The dimensional accuracy of the irreversible hydrocolloid impression material was studied using four different types of tray. The impressions of a fixed model with four distant reference points were made by using four specially designed impression trays.^{6,7} Tray positioning device, tray orientation and application of tray adhesive shown in (figure 2,3,4,5) The impressions were poured immediately with type IV dental stone, the casts were retrieved after 1 hour and the measurements of the models were taken with the help of travelling microscope after 24 hours of the cast removal from impression. Total 80 samples were made and compared in this study. The dimensional changes in the models made by using irreversible hydrocolloid impression material were evaluated and compared by performing statistical analysis.

One way ANOVA (analysis of variance) was applied to compare the dimensional changes among the models made by four impression trays. (i.e. between groups I, II, III and IV). (Table 1, Graphs 1, 2, 3 and 4) The comparison between all groups did not show any significant difference in the dimensional accuracy except group III (Perforated stock plastic tray).

Post hoc multiple comparisons were done by applying bonferroni t-test. Antero-posterior and cross arch distances were compared to evaluate the dimensional changes in between all the groups.

The antero-posterior distances (A-B and C-D) and cross arch distances (B-C and D-A) in all the groups were compared and found that the dimensional changes in all groups were insignificant except the Perforated stock plastic tray i.e. groups III, which showed highly significant differences.

4. Discussion

Diagnostic casts are typically made using an irreversible hydrocolloid impression material, which is one of the most commonly used impression materials in dentistry. The success of irreversible hydrocolloid impression material is due to its ease of manipulation, low cost, and the level of patient comfort when it is used clinically.^{2,3}

No agreement seems to exist regarding the maximum acceptable dimensional change for hydrocolloids from the master model to the stone die. Skinner et al suggested that a value of 0.1% was acceptable, while Marrant and Elphicle considered dimensional changes of 0.27% for one irreversible hydrocolloid to be clinically insignificant. Appleby et al claimed that a 0.22 “mean percentage of distortion” for combination of reversible and irreversible hydrocolloids was clinically acceptable.

In the present study the dimensional changes in models made with irreversible hydrocolloid impression material were only up to 50 microns by using perforated rimlock tray, perforated stock metal tray and perforated custom tray. But the dimensional variations were more than 300 microns with perforated stock plastic tray.^{8,9}

Good detail reproduction and dimensional accuracy of impressions are critical to obtaining the successful prosthodontics.¹⁰ Several authors have studied the stability and dimensional accuracy of impression materials. Most impression materials are capable of yielding clinically acceptable impressions when manipulated correctly. One manipulative variable that has not been studied in detail is the selection of impression trays i.e. the material and design of the tray.¹¹ In general, impression trays can be categorized as custom trays made specifically for a patient or stock trays that are available in a variety of sizes from a manufacturer.

Stock trays can be subcategorized in 2 general types: metal stock trays and plastic stock trays. The rigidity of commercially available plastic stock tray is questionable, plastic stock trays exhibited dimensional changes on removal from the dental arch. Clinically, the distortion of the trays may lead to distorted impressions, which on visual inspection appear to be acceptable, only to be found lacking on attempted insertion of the restoration.

5. Conclusion

The success of prosthodontic rehabilitation treatment includes the choice and correct recommendation of proper materials for the performance of clinical and laboratory procedures.¹² The present study was aimed to comparatively evaluate the dimensional accuracy of the irreversible hydrocolloid impression material using four different types of tray.

Accurate impressions are influenced by the impression material selection, impression material manipulation, impression technique, impression tray material, impression tray design, tray deformation potential, impression retention to the impression tray surface, impression material thickness, impression removal, and material used for making the casts and its compatibility with the impression material.^{13,14} Considering all of these variables and their interactions, it can be inferred that high impression accuracy is not easily achieved. Impression trays used for making impressions are either custom made or bought as stock

trays. The advantage of using a custom-made tray is that the impression material forms a uniform thickness inside the tray, while the advantage of using a stock tray is the convenience and cost, but uneven impression material thickness could be a problem.¹⁵

Hence the proper impression material and tray combination is crucial and very important to achieve desirable results in terms of dimensional accuracy and the quality of the impressions. Thus the results of the present study should be helpful to the dental practitioners in selection of the impression tray before making impressions with the irreversible hydrocolloid impression material.

Under the limitation of the experimental conditions, the following conclusions can be drawn,

1. All the trays used in this study for making impressions with irreversible hydrocolloid impression material could produce acceptable models with very negligible or clinically insignificant variation in the dimensional accuracy except the stock perforated plastic tray.
2. The most accurate models were obtained with custom self-cure acrylic tray.
3. Perforated Rimlock trays were more accurate than perforated stock metal trays.
4. The perforated stock plastic tray showed the highly significant variations in the dimensional accuracy of the models as compared with the other impression trays.
5. There is no statistically significant difference between perforated self-cure acrylic custom tray, perforated rimlock and perforated stock metal tray.

6. Source of Funding

None.

7. Conflict of Interest

None.

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