Journal of Pioneering Medical Sciences
Received: January 30, 2025 | Accepted: March 01, 2025 | Published: June 05, 2025
Volume 14, Issue 05, Pages 124-132

DOI https://doi.org/10.47310/jpms2025140519

Assessing the Accuracy of Dental Impressions Fabricated with Modified Plastic Trays Using Compound Wax and Metal Trays: A Comparative Study

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Abstract **Purpose:** This study assessed the accuracy of dental impressions generated from modified plastic trays using impression compound material compared with that of impressions made using stock metal and plastic trays. **Methods:** In this *in vitro* study, three types of trays-stock plastic trays, modified plastic trays and stock metal trays (control)-were used, with 30 impressions for each tray type. A Nissan typodont was used as the master cast with standardized prepared teeth. Polyvinyl siloxane impression material with light and regular bodies was used for the impressions. For the modified plastic trays, a disc of compound wax was heated in a water bath until the dough state was reached. Then, the dough was placed in the plastic tray and a preliminary impression was made using the wax. These impressions were scanned using a S600 ARTI SCANNER and statistical analysis employing a multivariate analysis of variance was conducted to evaluate the differences among the tray types. **Results:** Metal trays demonstrated the highest accuracy in dental impressions; however, they may cause patient discomfort. Modified plastic trays, using compound wax, showed significant improvements in accuracy over standard plastic trays, providing a viable alternative when metal trays are unavailable or unsuitable. **Conclusion:** The study highlights the potential of modified plastic trays as a comfortable and accurate alternative to metal trays. Further refinement and standardization of the modification process can enhance their performance, making them a durable option for dental impressions.

Key Words Dental impressions, Compound wax, Tray materials

INTRODUCTION

Replicating hard and soft tissues of dental arches is crucial when creating ideal diagnostic casts. These casts serve as the foundation for most dental prostheses and are a key component of most prosthodontic treatments. Attempting to create patterns for fixed dental prostheses directly in the oral cavity is not reliable or practical. Consequently, to achieve the necessary precision, it is imperative to create an impression of the dentition and the surrounding anatomical features [1]. The formulation of a treatment plan is reliant on the use of diagnostic casts, which serve as an essential starting point for creating a structured rehabilitation plan and are invaluable for comprehensively visualizing patients' current oral conditions [2]. The precision and quality of dental casts are influenced by various factors, including the materials chosen for casting and the precise timing of cast creation [3]. In addition to using appropriate impression material, achieving an accurate registration of both hard and soft tissues within the oral cavity necessitates the use of rigid impression trays and meticulous impression techniques. To create dental prostheses, a variety of impression techniques have been documented and recommended for obtaining clinically acceptable impressions [1].

Enhancing the precision of obtaining impressions and reducing dimensional variations are achieved through two primary techniques: conventional and digital impression methods. These approaches ensure the fabrication of precise working casts, essential for crown and bridge restorations [4].

The conventional approach to obtaining impressions remains the gold standard in clinical practice, providing a reliable reference for replicating intraoral conditions [1]. In contrast, conventional impression trays are prefabricated trays, available in various designs-tailored to standard arch sizes and shapes and intended for general use. The primary objective in constructing stock trays is to produce a sturdy tray capable of securely holding the impression material in place. Conversely, customized trays offer superior precision in obtaining impressions compared with stock trays. However, owing to the added time and expenses associated with custom trays, their practicality is limited in routine clinical practice. Hence, dentists typically option for more convenient and cost-effective stock trays [5]; stock trays continue to be a prevalent choice because of their ease of access and straightforward application despite the recommendation of custom trays to achieve greater impression precision. There is a misconception among practitioners that irregular parts of the impression may not undergo distortion and will adhere to the tray through adhesive. Additionally, some researchers believe that dimensional alterations that may arise during the setting process can be minimized or completely prevented by opting for alternative stock tray designs [3]. The foremost objective of constructing stock trays is to craft a robust tray that securely holds the impression material in place.

The reliability of the dimensional stability of dental impression materials is closely associated with the consistent use of thin impression materials. The thickness of a tray, its production method and its application technique all contribute to the thickness of the material [6]. Different materials can be used to decrease the thickness; one such material, impression compound materials, has been in use for over a century as a common method for creating an initial impression. Its cost-effectiveness and advantageous physical and mechanical properties continue to make it an essential resource in developing countries and educational institutions [7]. Impression compound materials are known for their high-viscosity, making them effective for mucocompressive impressions. One significant benefit of impression compound materials is their ease of adjustment due to their thermoplastic nature. The impression can be modified by removing, replacing or adding material until satisfactory results are achieved. This flexibility in manipulation assists in obtaining an accurate impression.[7] Considerations such as thickness, uniformity, placement of occlusal stops and the extent of the spacer play pivotal roles in tray design [6]. Additionally, when employing any type of tray, it is crucial to ensure complete seating and carefully consider its orientation and alignment. This perspective is substantiated by research indicating that consistently thin impression materials exhibit minimal dimensional change [6].

When obtaining an impression from the oral cavity, especially when recording undercut areas, impression materials are compressed against the tray. The extent of the undercut, material capacity for elastic recovery, duration of compression and storage conditions collectively influence the degree of material distortion that may occur [5]. In contemporary dental practice, silicone is the most frequently used elastomer, which has been subjected to an additional curing process. Multiple impression techniques can be used for these materials. In the two-stage process, two materials with different viscosities are used. Initially, putty material is deposited in a stock tray and then a low-viscosity wash is administered around the teeth simultaneously, with both materials setting simultaneously [7]. Precise selection and proper implementation of impression techniques and materials are pivotal in the creation of molds and the generation of precise dental stone casts. Over time, a variety of materials and impression techniques have been created to obtain flawless replication of intraoral structures [3]. The literature has extensively explored the precision of the cast and the correct fit of prosthetics is considerably affected by material choice and impression procedure. Some studies have presented evidence suggesting that the precision of the cast is more reliant on the impression technique utilized than the specific material chosen [8]. As indicated by the findings from various studies, the impression process seems to have a minimal influence on dimensional accuracy [1].

Utilizing a measuring device is essential for the assessment of dental casts. While manual measuring tools such as calipers are user-friendly and widely accessible, they have certain limitations. These traditional tools demand a significant amount of time for operation, are more prone to operator exhaustion and can only measure linear distances across two specific locations. Additionally, the dimensional differences that exist across a three-dimensional surface, including aspects like occlusogingival, mesiodistal and buccolingual dimensions, cannot be taken into account by conventional two-dimensional measuring methods [8]. A previous study has highlighted the advantages of utilizing a digitizer when assessing the dimensional changes in dental materials. The digitizer, as indicated by previous research [8], offers several notable advantages; it excels in terms of accuracy and reliability compared with manual devices. Its high level of automation significantly reduces the potential for operator errors. Additionally, it can record a larger number of data points, facilitating more comprehensive statistical analyses and enhancing its overall utility in dental cast evaluation [9]. On the other hand, digital superimposition has proven effective in extracting invaluable information and enabling well-informed decision-making. This technology enables precise comparisons and measurements, often beyond the capabilities of manual techniques [10]. Furthermore, laboratory scanners have become indispensable tools for capturing accurate three-dimensional data from dental impressions and models. Key evaluation methods encompass surface deviation analysis, which involves comparing the scanned surface to the reference model to identify discrepancies, as well as geometric metrics and color mapping [11].

In a study by Marcelo *et al.* [3], the primary aim was to assess whether the type of impression tray and its rigidity (metal or plastic) affected the dimensional precision of the resulting casts. These impressions were generated employing two distinct stock impression trays: one crafted from metal and the other from plastic. Both trays utilized polyvinyl siloxane impression material. The study concluded that the rigidity of the metal stock trays compared with that of the plastic stock tray led to superior outcomes, particularly in implant impressions involving a high-viscosity impression material (putty) [1].

A randomized clinical trial by Damodara *et al.* [2] aimed to assess the precision of diagnostic casts by utilizing three distinct tray types. Therein, seven participants were enrolled. Impressions were taken from each participant in a randomized order, utilizing one of three tray types: Plastic stock tray, plastic directed flow or perforated metal tray. Additionally, Vinyl Polysiloxane (VPS) impressions were obtained with custom trays and served as the control group for comparison. Following this, the impressions were disinfected and utilized to produce casts using type IV stones. A computer software analysis was used to measure the liner accuracy of these casts. In general, casts produced using plastic trays (both stock plastic and directed flow) exhibited values more closely aligned with those obtained from custom trays when compared with casts made with metal trays [2].

This study aimed to explore and assess the accuracy of impressions generated from a modified plastic tray using impression compound material and compare it with that of the impressions made using stock trays (metal and plastic trays). Additionally, it aimed to validate the use of a compound-modified plastic tray as an alternative technique in dental practice, offering a balance between accuracy and patient comfort.

Objectives

This study aimed to answer the question of whether impressions made using modified plastic stock trays were more accurate than those made using metal trays. To address this, the primary goal of the study was to determine whether the choice of impression tray material; metal or plastic and the material thickness significantly impacted the accuracy and precision of the impressions. The null hypothesis for this study was that there would be no significant difference in the dimensional accuracy of impressions produced using modified plastic trays compared with those produced with standard metal or plastic trays and that the accuracy would be lower for the plastic trays, particularly when using a compound impression material.

METHODS

In this *in vitro* study, a sample size of 30 samples for each tray type was used, as calculated using G-power software (power = 0.80). The three types of trays were as follows: metal trays (Group 1; control), plastic trays (Group 2) and modified plastic trays (Group 3). The impressions were obtained by a calibrated professional dentist to ensure standardization, utilizing a Nissan typodont as the master cast. The master cast featured standardized full-ceramic preparations for teeth #14 and #16, maintaining precision and consistency throughout the process (Figure 1). Guiding points were established on the mesial, distal, buccal and palatal sides of the prepared teeth to ensure consistency across measurements.

A S600 ARTI Zirkonzahn scanner was used to obtain an accurate digital scan of the master cast for comparative analysis.

Impression Technique and Tray Groups

Group 1 (Metal Tray)

Herein, prefabricated perforated metal trays were used with a single-step impression technique. A polyvinyl siloxane (PVS) impression material (Imprint 2, 3M ESPE) was utilized, combining regular body material for the tray with light body material injected onto the prepared tooth surfaces. The regular body material was allowed to be set for

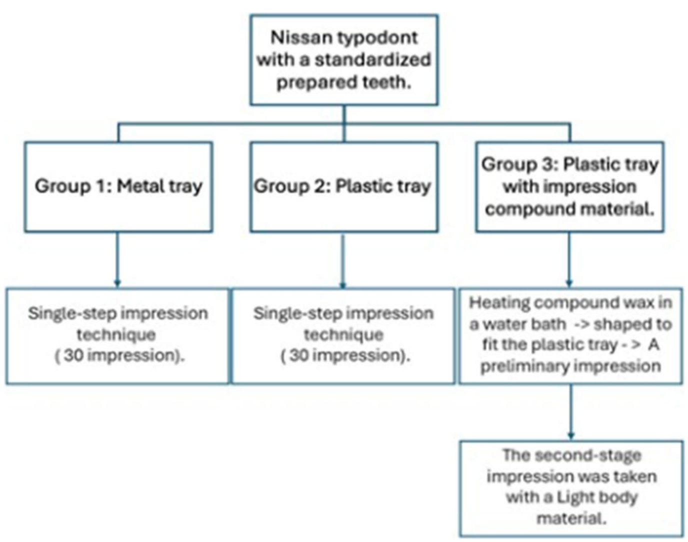

Figure 1: Methodology flowchart

Figure 2: Metal tray impression

Figure 3: Plastic tray impression

5 minutes within the tray, followed by the addition of the light body material. The tray was then carefully seated on the master cast with controlled finger pressure until it made contact with the base. This configuration was allowed to be set for an additional 5 minutes before the impression was removed (Figure 2).

Group 2 (Plastic Tray)

Similar to the method used in the previous group, prefabricated perforated plastic trays were used with a single-step impression technique. A PVS tray adhesive (3M/ESPE) was applied specifically to the plastic stock trays to ensure retention, as the metal trays in Group 1 were naturally perforated. The same impression steps from Group 1 were followed for the plastic trays to maintain consistency in procedure and timing (Figure 3).

Group 3 (Modified Plastic Tray)

The same prefabricated plastic tray used in Group 2 was modified for Group 3. A disc of Berlin compound wax (Figure 4) was heated in a water bath according to the manufacturer's instructions and placed inside the plastic tray to achieve a preliminary impression. The heated wax was evenly distributed within the tray to ensure uniformity across impressions. After setting for 5 minutes, a PVS tray adhesive was applied and a second-stage impression was performed using the light body PVS material. This impression was also allowed to be set for 5 minutes before gentle removal from the model (Figure 5).

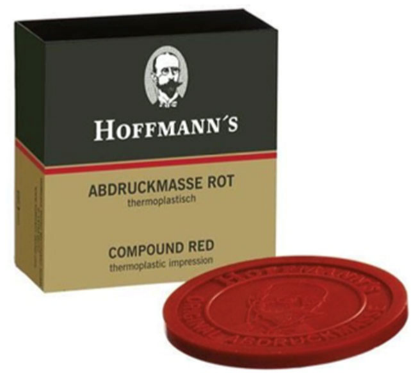

Figure 4: Berlin compound wax

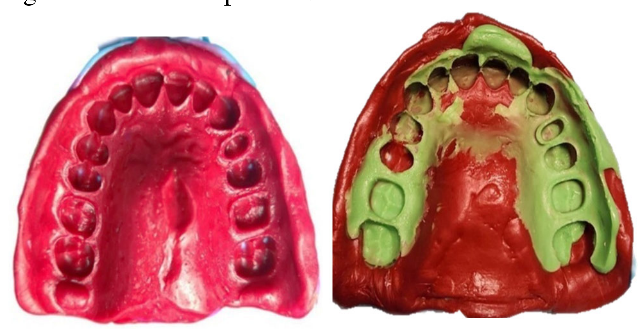

Figure 5(a-b): Modified plastic tray impression, (a) A preliminary impression was obtained using a heated Berlin compound wax disc placed within a modified prefabricated plastic tray and (b) Second-stage impression was acquired using light body polyvinyl siloxane (PVS) material following the application of PVS tray adhesive over the set preliminary impression

Statistical Analysis

All impressions were digitized and analyzed using a calibrated S600 ARTI Zirkonzahn scanner, with each scan conducted by a single calibrated operator to minimize errors and bias in the scanning process. The statistical analyses aimed to evaluate the impact of three key variables on the accuracy of dental impressions: tray type (metal, plastic and modified plastic), tooth (#14 and #16) and tooth surface (mesial, distal, buccal, palatal, mesiodistal and buccopalatal). The dimensional accuracy of the impressions was assessed by comparing the measurements from the three tray types with those from the master model using a superimposition technique. For each prepared tooth, six linear measurements were taken to capture the variations in dimensional accuracy across different surfaces.

The data were analyzed using multivariate analysis of variance (MANOVA) to examine the statistical significance of differences among the groups. The MANOVA test was chosen due to its ability to simultaneously analyze multiple dependent variables-specifically, the six linear measurements across the tooth surfaces-while accounting for intercorrelations among these variables. This approach allowed for a comprehensive assessment of how tray type, tooth number and tooth surface collectively influenced impression accuracy. Post-hoc tests with Bonferroni adjustments were conducted to further investigate pairwise differences between tray types and tooth surfaces, controlling for Type I errors. Statistical significance was set at $\alpha = 0.05$.

All statistical analyses were performed using SPSS software and the results were reviewed and validated by a statistician, Dr. X, to ensure accuracy and interpretability.

RESULTS

Descriptive Statistics

Table 1 displays the mean and standard deviation for each tray material in terms of mesial, distal, buccal and palatal differences.

Mesial Difference

Metal trays showed a slight positive mean difference of 0.0715, with a Standard Deviation (SD) of 0.1065, suggesting that they tended to slightly expand or maintain the dimension in the mesial direction, which may be beneficial for accurate impressions. Plastic trays presented a small negative mean (-0.0025) but with relatively high variability (SD = 0.1040), indicating that these trays tended to decrease mesial measurements inconsistently, which could compromise precision. Modified plastic trays had a positive mean of 0.0176 with a lower SD (0.0628), showing some improvement over plastic trays. This suggests that modified plastic trays may provide slightly more consistent measurements but still do not match the reliability of metal trays.

Distal Difference

Metal trays had a mean of 0.0559 with a low SD of 0.0289, demonstrating a stable and minimal increase in distal dimension, which is favorable for accurate replication. Plastic trays had a higher mean (0.0915) and a moderate SD (0.0704), indicating a slight increase in the distal measurement but with more variation. Modified plastic trays showed the highest mean (0.1497) and the largest SD (0.1704), suggesting a significant increase and higher variability in the distal measurements, which could affect the accuracy of distal replication.

Buccal Difference

Metal trays displayed stability with a mean of 0.0598 and a relatively low SD (0.0401), supporting their ability to produce consistent buccal measurements. Plastic trays had a slightly lower mean (0.0455) but greater variability (SD = 0.0990), suggesting some instability in buccal measurements. Modified plastic trays showed a small negative mean (-0.0111) with higher variability (SD = 0.1057), indicating a potential reduction in the buccal dimension, which may lead to less accurate impressions.

Palatal Difference

Metal trays demonstrated consistency with a mean of 0.0707 and a low SD (0.0496), indicating stable palatal measurements. Plastic trays showed a larger positive mean (0.3455) but with considerable variability (SD = 0.2826), making them less reliable. Modified plastic trays had a mean of 0.0758 with a moderate SD (0.1214), suggesting an improvement over plastic trays but still less consistent than metal trays.

These findings from descriptive statistics indicate that metal trays provide the most stable and accurate impressions across all dimensions, while plastic trays lead to more variability and have a tendency for dimensional reduction. Modified plastic trays show some improvements over plastic trays but still do not reach the consistency of metal trays.

Multivariate Analyses

The findings of multivariate analyses, as shown in (Table 2), confirm the significant impact of tray material on dental impression accuracy, with a p-value <0.001 across all dimensions (mesial, distal, buccal and palatal differences). This strong statistical significance indicates that tray material is a crucial factor in dimensional stability, thereby strongly rejecting the null hypothesis.

Both Pillai’s Trace and Wilks' Lambda for tray material yielded values (0.581 and 0.488, respectively) that confirmed significant overall differences between the tray types.

Table 1: Descriptive Statistics for Mesial, Distal, Buccal and Palatal Differences according to Tray Material

Difference	Tray Material	Mean	Std. Deviation	N
Mesial Difference	Metal	0.0715	0.1065	30
	Plastic	-0.0025	0.104	30
	Modified Plastic	0.0176	0.0627	30
	Total	0.0289	0.0974	90
Distal Difference	Metal	0.056	0.0289	30
	Plastic	0.0915	0.0704	30
	Modified Plastic	0.1497	0.1704	30
	Total	0.099	0.1134	90
Buccal Difference	Metal	0.0598	0.0401	30
	Plastic	0.0455	0.096	30
	Modified Plastic	-0.0111	0.1057	30
	Total	0.0314	0.0911	90
Palatal Difference	Metal	0.0707	0.0496	30
	Plastic	0.3455	0.2826	30
	Modified Plastic	0.0758	0.1214	30
	Total	0.1631	0.2197	90

Table 2: The findings of multivariate analyses for the relationship between tray materials and observed differences

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[e]
Intercept	Pillai's Trace	0.672	43.065[c]	4	84	<0.001	0.672	172.261	1
	Wilks' Lambda	0.328	43.065[c]	4	84	<0.001	0.672	172.261	1
	Hotelling's Trace	2.051	43.065[c]	4	84	<0.001	0.672	172.261	1
	Roy's Largest Root	2.051	43.065[c]	4	84	<0.001	0.672	172.261	1
Tray Material	Pillai's Trace	0.581	8.696	8	170	<0.001	0.29	69.57	1
	Wilks' Lambda	0.488	9.068[c]	8	168	<0.001	0.302	72.543	1
	Hotelling's Trace	0.909	9.436	8	166	<0.001	0.313	75.486	1
	Roy's Largest Root	0.712	15.130[d]	4	85	<0.001	0.416	60.52	1

The Partial Eta Squared values (0.290-0.416) suggested that the tray material accounted for a substantial portion of the variability in measurements, with metal trays showing the highest stability and accuracy

Pairwise Comparisons

The findings of pairwise comparisons (Table 3) detail the specific differences between tray materials across each dimension.

Mesiodistal Differences

Metal trays showed a statistically significant larger mesiodistal difference compared with plastic trays (mean difference = 0.076, p = 0.037), indicating that metal trays maintain slightly larger mesiodistal dimensions. Metal trays also demonstrated a significantly larger mesiodistal difference compared with modified plastic trays (mean difference = 0.132, p<0.001). This suggests that metal trays are more reliable for mesiodistal stability compared with modified plastic trays. The mesiodistal difference between plastic and modified plastic trays was not statistically significant (mean difference = 0.056, p = 0.193), indicating similar performance between these two materials in this dimension.

Distal Differences

The pairwise comparisons do not provide data for distal differences explicitly; however, based on the descriptive statistics, metal trays showed a slight increase in the distal dimension compared with plastic trays, though this difference was not statistically significant. Modified plastic trays displayed a higher mean distal difference but with substantial variability, suggesting potential instability in distal dimensions

Buccopalatal Differences

Metal trays had a significantly smaller buccopalatal difference compared with plastic trays (mean difference = -0.130, p = 0.035), indicating that metal trays provided more stability in this dimension. Metal trays also had a significantly lower buccopalatal difference compared with modified plastic trays (mean difference = -0.315, p<0.001). This highlights the superiority of metal trays in maintaining stable buccopalatal dimensions. Modified plastic trays exhibited a significantly higher buccopalatal difference than plastic trays (mean difference = 0.185, p = 0.001), suggesting that modified plastic trays might be less stable in maintaining buccopalatal accuracy.

Palatal Differences

The pairwise comparisons do not provide data for palatal differences explicitly; however, based on descriptive statistics, metal trays generally performed better than plastic trays. Modified plastic trays may offer improved performance for applications requiring palatal stability, though this requires further confirmation.

DISCUSSION

The results from this study provide insights into the effects of different tray materials (metal, plastic and modified plastic) on the precision of dental impressions across four key surface dimensions: mesial, distal, buccal and palatal. The data suggest substantial differences in dimensional stability and measurement accuracy based on the tray material used, which could have clinical implications for ensuring accurate dental impressions.

Accurate dental impressions are fundamental to the success of various dental procedures, such as fabricating prostheses and restorations. The choice of tray material-metal, plastic or modified plastic-significantly impacts the dimensional stability of these impressions across multiple measurements (mesial, distal, buccal and palatal). Studies, including those by Kulkarni *et al.* [1] and Pastoret *et al.* [12], have consistently shown that metal trays offer superior dimensional accuracy compared with plastic trays, particularly in fabricating fixed prostheses. This study contributes to the body of knowledge by examining the accuracy of dental impressions obtained using three types of trays: metal trays, plastic trays and plastic trays enhanced with compound wax, which acts as a mucocompressive material. The ability of compound wax to adapt under pressure enables it to capture more detailed impressions, offering the flexibility to adjust the impression until an optimal result is achieved [13].

This in vitro study aimed to identify which tray material provided the most precise impressions by analyzing 90 impressions using the general linear model. The analysis included mesial, distal, buccal and palatal differences across the tray materials, comparing their impacts on measurement accuracy. Consistent with previous studies, the findings

Table 3: Findings from pairwise comparisons to assess mean differences between the tray materials

Dependent variable	(I) Tray material	(J) Tray material	Mean difference (I-J)	Std. error	Sig.c Dependent variable (I) Tray material (J) Tray material Mean difference (I-J) Std. error Sig.c	95% Confidence interval for difference Lower bound	Upper bound
Mesiodistal difference	Metal	Plastic	0.059*	0.022	0.027	0.005	0.113
	Mesiodistal difference metal	Modified plastic	-0.088*	0.022	<0.001	-0.142	-0.034
Mesiodistal difference	Plastic	Metal	-0.059*	0.022	0.027	-0.113	-0.005
	Mesiodistal difference plastic	Modified plastic	-0.147*	0.022	<0.001	-0.2	-0.093
Mesiodistal difference	Modified plastic	Metal	0.088*	0.022	<0.001	0.034	0.142
	Mesiodistal difference modified plastic	Plastic	0.147*	0.022	<0.001	0.093	0.2
Buccopalatal difference	Metal	Plastic	0.052	0.032	0.335	-0.027	0.131
	Buccopalatal difference metal	Modified plastic	-0.046	0.032	0.472	-0.125	0.033
Buccopalatal difference	Plastic	Metal	-0.052	0.032	0.335	-0.131	0.027
	Buccopalatal difference plastic	Modified plastic	-0.098*	0.032	0.01	-0.177	-0.019
Buccopalatal difference	Modified plastic	Metal	0.046	0.032	0.472	-0.033	0.125
	Buccopalatal difference modified plastic	Plastic	0.098*	0.032	0.01	0.019	0.177

indicate that metal trays exhibit better outcomes in maintaining or slightly enhancing dimensional accuracy compared with plastic trays [14]. This result reinforces the recommendation of using metal trays for dental procedures that require high precision, particularly for impressions with high-viscosity materials, as seen in the study by Marcelo et al., which demonstrated the rigidity of metal trays as advantageous in implant impressions [1].

Interestingly, in a study by Damodara *et al.* [2], plastic trays produced impressions with measurements more aligned with those of custom trays than those of metal trays in some diagnostic casts. However, our study reaffirms the consensus that metal trays, due to their rigidity, offer more consistent dimensional stability across different measurements. The modified plastic trays used in our research, which included compound wax, showed some improvements over standard plastic trays by achieving better dimensional stability; however, they could not match the accuracy of metal trays.

Differences between Tooth #14 and Tooth #16

An important aspect of this study was the comparative analysis of two teeth-Tooth #14 and Tooth #16-which highlighted variations in dimensional stability based on tray material. Tooth #14 demonstrated higher mesial and distal variability when plastic trays were used, suggesting that the shape and positioning of this tooth may influence the impression outcome. In contrast, Tooth #16 exhibited greater buccopalatal variability, particularly when modified plastic trays were used. This difference could be due to the anatomical and positional distinctions between these teeth, as Tooth #16 is typically a second molar, which may be more challenging to access and stabilize in impressions.

The data revealed that for Tooth #14, metal trays provided the most consistent mesiodistal measurements, maintaining dimensional integrity across impressions. Modified plastic trays also performed relatively well for Tooth #14, showing improved stability over standard plastic trays but with some compromise in accuracy compared with metal trays. However, for Tooth #16, metal trays showed superior dimensional stability across all measurements, particularly in buccopalatal dimensions, which are crucial for accurate occlusal fitting. On the other hand, plastic trays displayed significant buccopalatal dimensional reductions for Tooth #16, possibly due to their flexibility, which may lead to compression and distortion in posterior areas where access is restricted.

These findings underscore the need to consider anatomical differences and accessibility issues during the fabrication of impressions, as different teeth may respond to various tray materials differently. Clinicians must demonstrate heightened caution when managing posterior teeth, particularly Tooth #16, as these areas often necessitate the use of tray materials with superior rigidity such as metal to mitigate the risk of dimensional distortion.

General Findings and Clinical Implications

The general linear model analysis, supported by Levene's Test of Equality of Error Variances, demonstrated significant differences in dimensional measurements across the tray materials. This statistical validation strengthens the reliability of our findings, as the test confirmed unequal variances among groups, indicating inherent variability across tray types. The corrected model analysis emphasized that tray material significantly influences dental measurements, particularly in mesial and palatal differences. Metal trays generally maintained or enhanced these dimensions, whereas plastic trays tended to reduce them. The enhanced rigidity provided by metal trays appears to contribute to this outcome, minimizing flexion that could otherwise distort impressions.

The rigidity of tray material is a critical factor in fixed partial denture impressions. Even minor flexing in plastic trays can lead to impression distortion, a factor often undetectable until the insertion of the final prosthesis [14]. Impression compounds, such as the wax used with modified plastic trays, provide a malleable but firm material that can be adjusted to achieve more precise impressions. The ability to modify these trays through material additions or adjustments enhances their adaptability, potentially reducing distortions typically associated with plastic trays. Once cooled, the compound wax in modified plastic trays solidifies to conform accurately to the teeth and surrounding tissues, enhancing rigidity and decreasing the flexibility of the tray, thereby improving impression quality [13].

CONCLUSIONS

This study provides valuable insights into the impact of tray material on the accuracy of dental impressions. Metal trays emerged as the most accurate option but their potential to cause patient discomfort highlights the need for viable alternatives. Modified plastic trays present a promising alternative that considers patient comfort, demonstrating significant improvements over standard plastic trays. This makes them a viable option when metal trays are unavailable or unsuitable. With further refinement and standardization of the modification process, their performance may be enhanced, potentially offering a durable and cost-effective alternative to metal trays.

Limitations

This study has several limitations:

- The in vitro setting may not fully replicate clinical conditions, where variables such as saliva, patient movement and oral environment factors can affect impression accuracy
- The absence of disinfection protocols for the impressions may have influenced the results, as the presence of disinfectants could alter the properties of the impression materials and trays
- The study also did not measure the impact of severe undercuts, which are common in clinical settings and can limit the accuracy of impressions

Acknowledgement

Special thanks to the Deanship of Scientific Research (DSR) and the faculty of dentistry at King Abdulaziz University, Jeddah for supporting this project.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

Ethical Approval

The research proposal was approved by the regional research and ethics committee of King Abdulaziz University with an Ethical Approval number (171-11-23).

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