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Assessment of final impressions and master casts in complete denture prosthodontics – analytical survey

Ocena wycisków i modeli roboczych w wykonawstwie protez całkowitych – badanie analityczne

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complete denture, final impression, master cast, impression defects, dental technician

HASŁA INDEKSOWE:
proteza całkowita, wycisk czynnościowy, odlew roboczy, ubytki wycisków, technik dentystyczny

Summary

Background. *The accuracy of final impressions and master casts is critical for the fit and function of complete dentures. Discrepancies between clinical situations, impressions, and master casts can compromise prosthetic outcomes.*

Aim of the study. *This prospective analytical survey aimed to evaluate criteria of secondary impressions and master casts, analyse their validity and application in the subsequent prosthetic workflow, and compare the consistency of impression and cast validation criteria between the clinician investigator and the dental laboratory technician.*

Material and methods. *A total of 101 secondary maxillary impressions and 84 master casts were analysed over a four-month period. Impressions and casts were independently assessed by the clinician investigator and technician.*

Results. *Defects were observed in 99% of impressions by the clinician investigator and*

Streszczenie

Wprowadzenie. *Dokładność wycisków czynnościowych i modeli roboczych ma kluczowe znaczenie dla dopasowania i funkcjonalności protez całkowitych. Rozbieżności między sytuacjami klinicznymi, wyciskami i modelami roboczymi mogą negatywnie wpływać na wyniki protetyczne.*

Cel badania. *Celem tego prospektywnego badania analitycznego była ocena kryteriów wycisków i modeli roboczych, analiza ich trafności i zastosowania w późniejszym procesie protetycznym oraz porównanie spójności kryteriów walidacji wycisków i modeli roboczych pomiędzy klinicystą prowadzącym badanie a technikiem dentystycznym.*

Materiał i metody. *W ciągu czterech miesięcy przeanalizowano łącznie 101 wycisków czynnościowych szczęki i 84 modele robocze. Wyciski i modele robocze zostały niezależnie ocenione przez klinicystę prowadzącego badanie i technika.*

83.2% by the technician. Most common defects included compression, air bubbles and voids. Agreement between clinician investigator and technician evaluations was 67% for impressions and 78.6% for master casts. Significant associations were found between the materials used and defects such as tissue compression (p = 0.017) and poorly defined anatomical landmarks (p = 0.042).

Conclusions. *Despite shared evaluation criteria, clinicians and technicians differed in their validation decisions, highlighting the importance of interprofessional communication.*

Wyniki. *Klinicysta prowadzący badanie stwierdził wady w 99% wycisków a technik w 83,2%. Najczęstsze wady obejmowały kompresję, pęcherzyki powietrza i puste przestrzenie. Zgodność ocen klinicysty i technika wyniosła 67% dla wycisków i 78,6% dla modeli roboczych. Stwierdzono istotne zależności między zastosowanymi materiałami a defektami, takimi jak ucisk tkanek (p = 0,017) i słabo zdefiniowane anatomiczne punkty orientacyjne (p = 0,042).*

Wnioski. *Pomimo wspólnych kryteriów oceny, lekarze i technicy różnili się w swoich decyzjach dotyczących walidacji, co podkreśla znaczenie komunikacji międzyprofesjonalnej.*

Introduction

The precise intraoral fit of a complete denture is contingent upon the accuracy of the impression and the fidelity of its reproduction throughout the fabrication process. This necessitates a high degree of conformity among the original clinical situation, the impression and the resultant master cast. Being positive replicas of oral anatomy, master casts are fundamental to the prosthetic workflow. They provide the essential foundation for constructing prosthetic components and serve as a critical reference for quality control at various procedural stages. It is, therefore, imperative that both the impression and the master cast constitute the most accurate possible transmission and replication of the intraoral condition.[1] To ensure precise prosthetic adaptation and optimal clinical outcomes, clinicians and dental technicians must employ consistent, validated criteria for the interpretation and evaluation of these interdependent working materials.[2,3]

The present study was conducted to evaluate criteria of final impressions and master casts, analyse their validity and compare the consistency of impression and cast validation criteria between the clinician investigator and the dental laboratory technician.

Material and methods

Context

A prospective analytical survey was conducted over a 4-month period, from March to June 2025, in the Department of Complete Removable Prosthesis at the University Hospital of Dental Medicine of Monastir

Material

The study focused on the secondary maxillary impression, as well as the master cast derived from its pouring.

Inclusion criteria:

– secondary impressions of an edentulous maxillary arch, regardless of the material of the border modeling and the impression, and all master casts derived from their pouring,
– class I, II and III of sangiuolo edentulous upper jaw.

Exculsion criteria

– incompletely or poorly filled out survey forms,

– mandibular impressions and their master casts,
– cast in white plaster type I.

Study Protocol

Operators

The impressions and their master casts were evaluated by two operators: an clinician investigator and laboratory technicians. The clinician investigator did not interfere in the processing of the impressions, unlike the technician who is actively involved in the process of casting of the impression.

Examiner Preparation and Harmonization

Before the beginning of the study, a preliminary discussion session was conducted between the clinician investigator and the participating laboratory technicians in order to explain the study protocol and data collection process. Evaluation criteria for impression and master cast assessment were discussed, and operational definitions were standardized to minimize subjective interpretation. The aim of that session was to improve consistency in the understanding of the evaluated defects and validation judgments. However, no formal examiner calibration or inter-examiner reliability testing was performed prior to the study.

Data Collection

– data were collected on a survey form that contains six main sections:
– impression general data,
– impression interpretation data
– impression validation data,
– impression technical processing,
– master cast interpretation data,
– master cast validation data.

The identification of the impressions and the collection of data were performed by an clinician investigator. However, the interpretation and validation of the impressions and the master casts were carried out separately by the two operators: the clinician investigator and a technician.

At the end of the examination and validation of the impressions, three judgments were possible:
– impression accepted outright,
– pouring of the impression before deciding,
– impression rejected outright.

At the end of the interpretation and validation of the master cast, several criteria were evaluated, and three judgments were possible:
– master cast accepted outright,
– master cast rejected outright,
– master cast accepted after correction.

Standardization of Evaluation Criteria

The evaluation of impressions and master casts was based on predefined clinical criteria discussed prior to the study between the clinician investigator and the participating laboratory technicians. The assessed defects included compression, air bubbles, voids, poorly defined anatomical landmarks, border deficiencies, surface defects and fractures.

For standardization purposes, defects considered major, such as marked tissue compression, significant anatomical distortion, fractures or major border deficiencies were regarded as incompatible with direct validation, and could justify rejection or the need for correction. Minor defects, including small air bubbles or limited surface irregularities, were evaluated according to their extent and clinical location, and could still allow validation or correction when deemed clinically acceptable.

Statistical analysis

Data were analysed using SPSS version 22. Variable frequencies were calculated, and the chi-square test was applied for statistical analysis. A p-value < 0.05 was considered statistically significant.

Table 1. Distribution of the sample of impressions analysed according to the impression materials used

Maxillary impressions (N=101)											
Border modeling material						Impression material					
Compound paste (conventional green stick)		Polyvinyl siloxane (PVS)		Polyether		Polyether		Light viscosity silicone		Polysulfide	
(%)	N	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n
41.6	42	57.4	58	0.99	1	46.5	47	32.7	33	20.8	21
Maxillary master casts (N'=84)											

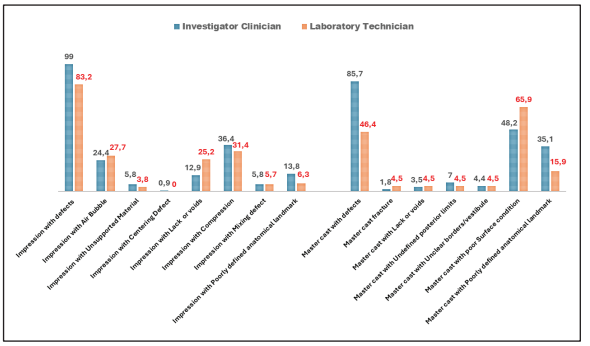

Fig. 1. Distribution (%) of Impression and Master Cast Defects According to Evaluator.

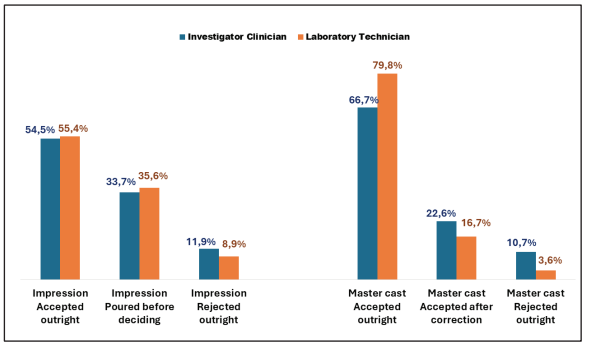

Fig. 2. Validation Decisions According to Evaluator.

Results

Impression general data

Our sample consisted of 101 maxillary secondary impressions and 84 casts evaluated in second step after the pouring of the accepted impression (outright or poured before deciding).

The material used for border modeling was mainly polyvinylsiloxane (high-viscosity silicone) 57.4%.

For the impression material, polyether and light silicone were most commonly used, while only 20.8% of cases used polysulfide. (Table 1)

Defects and validation

The analysis of 101 maxillary secondary impressions showed that 99% of cases presented defects according to the clinician investigator, compared with 83.2% according to the technician. The most frequently reported issues for the clinician were compression and air bubbles, with no tears observed. For the technician, the most common defects included compression, air bubbles and voids. (Fig. 1)

Regarding validation, only 54.5% of impressions were accepted outright by the clinician investigator, while 11.9% were immediately rejected. In contrast, 55.4% of impressions were accepted by the technician, and 35.6% were cast before a final decision was made. (Fig. 2)

For the casts, among the 84 casts obtained, 85.7% were identified as defective by the clinician investigator, whereas only 46.4% were classified as defective by the technician. The defects most frequently noted by the clinician involved surface quality and poorly defined

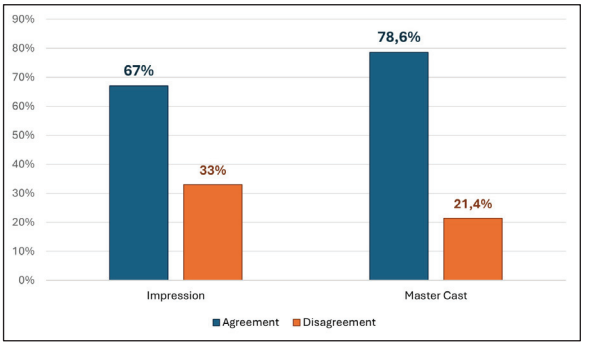

Fig. 3. Concordance between the clinician investigator's and technician's judgments regarding impressions and master casts.

anatomical landmarks, while fractures were observed in only 1.8% of cases. According to the technician, surface defects were the most prevalent, representing 65.9% of the issues reported. (Fig. 1)

Regarding validation outcomes, 66.7% of casts were accepted outright by the clinician, 22.6% were accepted after correction, and 10.7% were immediately rejected. From the technician's perspective, 79.8% of casts were accepted outright, 16.7% were accepted after correction, and only 3.6% were immediately rejected. (Fig. 2)

Concordance between the clinician investigator's and technician's judgments regarding impressions and master casts

In general, agreement between the assessments given by the clinician investigator and the technician, regardless of the decision, was observed for 67% of the impressions analysed. Agreement on the master cast evaluation reached 78.6%. (Fig. 3)

Analytic results

The materials used for the border molding and final impression have a statistically significant correlation with two key defects: tissue compression (p =0.017) and poorly defined anatomical landmark (p = 0.042).

The validation assessment of the impression showed a statistically significant association with two types of defects: compression (p = 0.048) and poorly defined anatomical landmark (p = 0.01).

Similarly, a significant relationship was observed between the validation of the master cast and the following defects: unclear

T a b l e 2. Analytic results

	Judgement factor	p
Validation of the impression (Acceptance/Rejection)	Compression	0.048
	Voids	0.029
	Poorly defined anatomical landmark	0.01
Material (Border molding/ Final impression)	Compression	0.017
	Poorly defined anatomical landmark	0.042
Validation of the master cast (clinician investigator	Undefined posterior limits	0.009
	Poorly defined anatomical landmark (master cast)	0.006
	Unclear borders/vestibule (master cast)	0.013
Validation of the master cast (Technician)	Undefined posterior limits (master cast)	0.045
Rejection of the master cast (clinician investigator)	Fracture (master cast)	0.017

borders (p = 0.009), poorly defined anatomical landmarks (p = 0.006), and uncleared borders (p = 0.013).

Rejection of the cast was significantly associated only with fractures (p = 0.017). (Table 2)

Discussion

Jayaraman S et al. (2018) in his review mentioned that the techniques and materials used for final impressions in complete dentures date back to the early 1900s.[4] Impressions may be taken using either an open-mouth or closed-mouth approach, performed in one or two steps. Clinicians can adopt a single-stage method (abbreviated impression) or a two-stage method, where a preliminary impression is made for diagnostic purposes or tray construction, followed by the final impression.[5]

The physical properties of impression materials are clinically expressed through their ability to flow within the custom tray under controlled pressures – whether compressive or relieving, occlusal or digital. This action takes place during evacuation and throughout polymerization. Thus, beyond selecting a material to apply selective pressure (based on anatomical support or mucosal quality), it is crucial to control the mechanical action of the material during impression taking: applying active pressure at the prosthetic equilibrium center during tray insertion and maintaining this balance throughout polymerization.[5,6]

Final impressions for complete dentures can be fabricated using a variety of techniques and materials. Impression techniques are typically categorized as mucostatic, mucocompressive, selective pressure, functional, or neutral-zone approaches. Commonly used impression materials include impression plaster, resin-based waxes, zinc-oxide eugenol paste, alginate, polysulfide, addition silicone, and polyether.[4,5,7]. (Fig. 4)

A study conducted in India by *Navjot Singh*, *Gurpreet Kaur* and *Kirtan Kaur* compared functional and conventional technique in secondary impression. The authors reported that functional secondary impressions performed using denture bases with occlusal rims and established jaw-relation records produced superior clinical outcomes compared with conventional techniques.[8]

Our survey revealed a significant correlation between the materials used for border molding and final impressions and the occurrence of defects such as tissue compression and poorly defined anatomical landmarks, both of which compromise denture retention. This may be explained by the frequent use of polyvinyl siloxane, a material known for its compressive properties. According to *Sarkis* et al. (2024), the dimensional accuracy of master casts varies significantly depending on the impression material used, with polyvinyl siloxane demonstrating superior accuracy compared to alginate but showing compression effects under excessive pressure.[9]

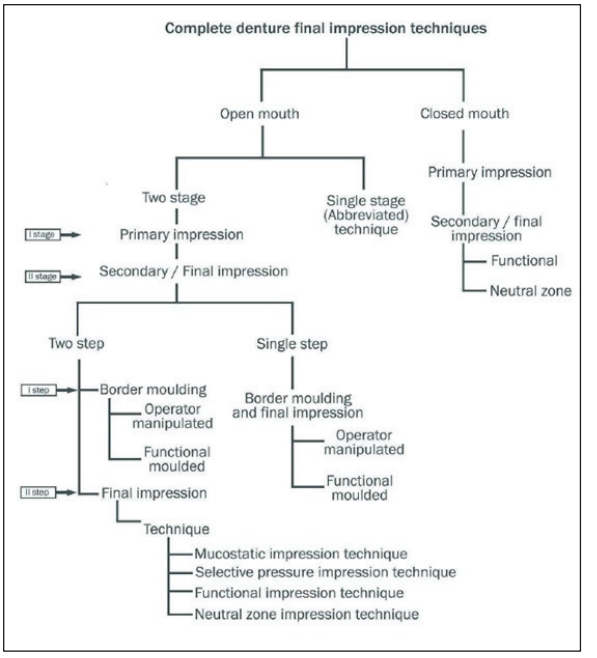

Fig. 4. Complete denture final impression techniques.

However, other studies have reported different – or even opposing – results. A study by *Renu B. Pachar* et al. (2018) found that dentures fabricated using green stick compound with a light-body wash exhibited the lowest mean retention, whereas impressions made with polyether achieved the highest retention, followed by putty rubber base combined with a light-body wash. Another study conducted at J. Ayub Medical College Abbottabad (2013), comparing retention, stability, comfort, and working time between green stick compound and PVS techniques, reported no significant differences between the two groups. Furthermore, *Renu Gupta* et al. (2015), in a study involving twenty edentulous subjects, observed that heavy-bodied PVS used for border molding provided better retention than traditional modeling compound.[10-12]

In our study, a statistically significant relationship was observed between the validation assessment of impressions and the presence of specific defects, including tissue compression, poorly defined anatomical landmarks, and voids. To minimize these issues during impression taking, several guidelines should be implemented: for compression, a tray fabricated from clear acrylic resin that fully extends to the height and width of the cast borders should be used, with relief areas on the intaglio surface corresponding to tissue blanching to reduce pressure, and holes in the tray can help decrease material pressure and minimize tissue distortion[13]; for poorly defined anatomical features, impressions should be taken under controlled occlusal pressure, using an appropriate impression material and ensuring that the custom tray adequately covers all relevant anatomical landmarks; for voids or lack of material, a sufficient quantity of impression material should be used with adequate distribution throughout the tray. As emphasized by *Kouveliotis* and *Zoidis*, standardized validation criteria for final impressions and master casts are essential to ensure reproducible quality control in complete denture prosthodontics.[1]

The analysed casts were obtained either from impressions that were accepted outright or from those whose validation was performed after pouring ("poured before deciding"). Among the 84 casts examined, nine were rejected by the clinician investigator, corresponding either to impressions for which visual inspection alone was inconclusive or to casts that were inadequately poured by the dental technician. Indeed, even a meticulous visual examination does not always reveal certain defects that become apparent only after the impression has been poured. *Friberg* and *Björn* (2022) demonstrated that master cast evaluation after pouring is critical, as different impression techniques yield significantly different levels of cast accuracy in edentulous patients.[14] For this reason, *Caire* and *Hoornaert* regard the master cast as the most reliable means of validating an impression, as it enables the detection of defects and the evaluation of the cast's conformity with the original impression.[3]

A discrepancy between the assessments made by the clinician investigator and the dental technician, regardless of the final decision, was observed in 33% of the impressions analysed, while disagreement remained in 21.4% of master cast evaluations. This lack of concordance may be explained by gaps in knowledge between them, insufficient information about the clinical situation, or differences in the evaluators' thresholds of acceptability. *Attia* et al. (2024) conducted a survey of complete denture prosthodontic procedures in dental schools and found significant variations in standards and practices, highlighting the need for harmonized evaluation criteria across clinical and laboratory settings.[15] To address these issues, it is recommended to regularly update theoretical and practical knowledge, emphasize data sharing through laboratory work sheets,

carefully consider material selection based on market availability, and organize joint meetings between clinicians and technicians to discuss cases and harmonize evaluation criteria.[1,15]

Al-Shammari et al. (2023) in their systematic review on master cast accuracy in edentulous patients confirmed that multiple factors contribute to cast inaccuracy, including impression material properties, pouring technique, stone expansion, and technician skill level.[16] *Al-Shammari* et al. (2022) previously reported that alginate impressions demonstrate limited accuracy for stone cast reproduction, which may explain some of the casting defects observed in clinical practice.[17]

The interpretation of the present findings should also be considered in the context of contemporary digital prosthodontic workflows. In recent years, digital impressions, CAD/CAM technologies and 3D-printed working models have progressively transformed the complete denture fabrication procedures. Compared with conventional impression techniques, digital workflows may reduce certain defects related to impression material manipulation, air bubbles, deformation during pouring, or cast fractures.[16,18]

Nevertheless, digital procedures are not free from inaccuracies. Several studies have reported limitations related to intraoral scanning of edentulous arches, particularly in recording movable soft tissues, peripheral borders and functional vestibular anatomy. In addition, errors related to image stitching, software processing, CAD design, and 3D-printing accuracy may also affect the precision of the final prosthesis.[16,18,19]

Despite these technological advances, the fundamental principles of impression validation and quality control remain essential. Effective communication between clinicians and dental technicians, as well as the use of standardized validation criteria, continues to play a central role in ensuring the accuracy and clinical success of complete denture prosthodontic workflows, whether conventional or digital.[1,6,20]

Study limitations

This study presents several limitations. First, the study was conducted in a single academic center, which may limit the external validity and generalizability of the findings. Second, the laboratory technician involved in the evaluation was also responsible for impression pouring, which may have introduced observer bias. Although the evaluations were performed independently, complete blinding was not feasible.

In addition, defect detection and validation decisions were primarily based on visual inspection. Despite the use of predefined evaluation criteria discussed prior to the study, no validated scoring system or quantitative assessment scale was applied. Consequently, a degree of subjective interpretation may have persisted between evaluators. Furthermore, no formal examiner calibration or quantitative inter-examiner reliability assessment was performed before the study, which may also have contributed to variability in interpretation and validation judgments.

Finally, the present study focused on the detection and validation of impression and master cast defects without establishing a direct correlation between these findings and clinical outcomes such as denture retention, stability, adaptation, or patient satisfaction. Future studies should incorporate standardized and validated assessment systems, inter-examiner reliability analysis, and clinical outcome evaluation in order to improve reproducibility and clinical relevance.

Conclusion

In this study, the clinician investigator and the laboratory technician agreed on the same criteria for interpreting and evaluating

impressions and working casts; however, their professional decisions and approaches differed regarding validation. Effective communication between clinicians and technicians is essential to ensure conformity between the clinical situation, the impression, and the working cast, thereby helping to prevent prosthetic failures.

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