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UPOREDNA ANALIZA TAČNOSTI I PRECIZNOSTI TOTALNIH PROTEZA IZRAĐENIM KOMPJUTERSKI VOĐENOM TEHNOLOGIJOM U POREĐENJU SA KONVENCIONALNOM TEHNIKOM

COMPARATIVE ANALYSIS OF ACCURACY AND PRECISION IN COMPLETE DENTURES FABRICATED USING COMPUTER-AIDED TECHNOLOGY COMPARED TO CONVENTIONAL TECHNIQUES

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Sažetak

Cilj: *Ova in vitro studija imala je za cilj da proceni tačnost i preciznost baze totalnih proteza izrađenih computer-aided design/computer-aided manufacturing (CAD/CAM) tehnologijom i uporedi ih sa totalnim protezama izrađenim tehnikama kompresionog i injekcionog presovanja.*
Materijali i metode: *Adaptacija baza proteza procenjivana je na 30 totalnih proteza izrađenih koristeći tri različite tehnike: kompresiono presovanje, injekciono presovanje i computer-aided design/computer-aided manufacturing (CAD/CAM) tehnologija. Master model sa bazom od legure kobalt-hroma skeniran je kako bi se dizajnirala i izradila master CAD/CAM totalna proteza. 30 gipsanih modela napravljeno je iz ovog master modela i potom skenirano. Na osnovu CAD/CAM master proteze, izrađeno je 30 totalnih proteza, za svaku ispitivanu tehniku po 10 proteza. Sve proteze su bile potopljene u destilovanu vodu na 30 dana, a njihove bazalne površine skenirane su nakon 2 dana i ponovo nakon 30 dana. Merenja su vršena u šest ključnih regija koristeći 3D softver za analizu kako bi se uporedile površine gipsanih modela i proteza. Primenjene su statističke metode analize za ispitivanje razlika u parametrima unutar svake grupe (intra-grupa) i između grupa (inter-grupa).*
Rezultati: *U rangiranju na osnovu medijane i interkvartilnog raspona za svih 12 ispitivanih parametara, CAD/CAM tehnika je pokazala najbolju kombinaciju tačnosti baza proteza i reproduktivnosti tehnike.*
Zaključak: *Baze totalnih proteza izrađenih CAD/CAM tehnologijom pokazale su veću tačnost i preciznost u poređenju sa onima proizvedenim tehnikama kompresionog i injekcionog presovanja. Visoka tačnost i preciznost baze CAD/CAM proteza dovela bi do bolje retencije, poboljšane žvačne sposobnosti i, samim tim, boljeg kvaliteta života za korisnike totalnih proteza.*

Ključne reči: *impakcija očnjaka CAD/CAM, totalna proteza, preciznost proteza, reproduktivnost*

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Abstract

Aim: *This in vitro study aimed to evaluate the accuracy and precision of the denture base of complete dentures fabricated using computer-aided design/computer-aided manufacturing (CAD/CAM) technology and to compare these results with those for complete dentures fabricated using compression and injection molding techniques.*
Materials and Methods: *The adaptation of denture bases was evaluated for 30 complete dentures fabricated with three different techniques: compression molding, injection molding, and CAD/CAM. A master model with a cobalt–chrome alloy base was scanned to design and fabricate a master CAD/CAM complete denture. A total of 30 plaster casts were developed from this master model and subsequently scanned, with 10 complete dentures fabricated using each fabrication method. All dentures were immersed in distilled water for 30 days, and their intaglio surfaces were scanned at 2 days and again at 30 days. Measurements were taken in six key regions using 3D analysis software to compare the cast and CD surfaces. The applied statistical analysis methods were used to examine differences in the parameters within each group (intra-group) and between groups (inter-group).*
Results: *Regarding the ranking based on medians and interquartile ranges across all 12 evaluated parameters, the CAD/CAM technique demonstrated the best overall combination of denture base accuracy and reproducibility. A Kruskal–Wallis analysis showed significantly greater CAD/CAM CD base precision in the vestibular surface area.*
Conclusion: *The high accuracy and precision of the CAD/CAM CD base are expected to result in better retention, improved masticatory ability, and, thus, a better quality of life for CD wearers.*

Key words: *computer-aided design/computer-aided manufacturing, complete denture, polymethyl methacrylate, denture accuracy, reproducibility*

Introduction

Edentulism is considered a disability and a significant oral health issue worldwide[1]. This condition compromises oral health, affects chewing and speech functions, alters esthetic appearance, and ultimately impacts the quality of life of affected individuals. Despite the advancements and options available through implant-supported therapy, the conventional use of complete dentures (CDs) remains the preferred choice for most edentulous patients due to various anatomical, physiological, or financial limitations[2].

Since the introduction of polymethyl methacrylate (PMMA) by Dr. Walter Wright in 1936, the processes for fabricating CDs have remained mainly unchanged[3]. PMMA rapidly became the preferred material for denture bases because of its generally acceptable clinical characteristics, although it does have some downsides[4]. One of the main drawbacks of PMMA is its volumetric contraction of 6% to 7% during the polymerization reaction, which results in dimensional changes in the denture base, that is, a linear distortion ranging from 0.45% to 0.9%. Additional distortion in the denture base is attributed to the thermal expansion coefficient of the PMMA material[5]. Several methods have been developed to overcome these issues and improve the qualities of PMMA. However, the most popular process for processing dentures is still compression molding, also known as the "pack and press" method[4]. Conversely, injection molding has been shown to be a superior technique for reducing volumetric shrinkage[6]. In addition to material issues, patients and dentists find the traditional denture fabrication procedure time-consuming, as it involves at least five clinical steps and a substantial amount of laboratory work.

The development and advancement of computer-aided technology in CD fabrication aim to address the challenges associated with traditional CDs and streamline the fabrication process. At present, two computer-aided design/computer-aided manufacturing (CAD/CAM) methods are used to create complete dentures: subtractive milling from a pre-polymerized PMMA block and additive manufacturing (3D printing), in which the denture base is formed through VAT polymerization using a light-cured liquid[7]. Using computer-aided technology to manufacture CDs entails gathering clinical data and using computer software to design prostheses digitally. The subtractive method is currently the more widely used approach[8,9]. Beyond the improved fabrication process, the quality of CAD/CAM CDs is further enhanced by the superior physical and mechanical properties of the materials used for the denture bases in digital manufacturing. The PMMA blocks used for subtractive milling are industrially polymerized under controlled conditions, utilizing high temperatures and pressure during the injection process[10].

These highly condensed and cross-linked pre-polymerized acrylic blocks successfully address the problems of polymerization shrinkage and dimensional distortion observed in conventional PMMA dentures. One of the most important factors influencing the quality of CDs is achieving maximal congruence between the denture base and the underlying tissues[11]. Retention, stability, and, consequently, masticatory performance and speech directly depend on the intimate fit of the denture to the underlying tissues.

The dimensional accuracy of CAD/CAM-fabricated CDs, compared to conventionally fabricated ones, has been the subject of several studies. The first published study by Goodacre et al., which compared the adaptation of the prosthetic base between CAD/CAM CDs and CDs fabricated using three different traditional techniques, confirmed the superiority of CAD/CAM CDs in terms of the accuracy of the denture base and reproducibility[12]. In contrast to the first study by Srinivasan et al., no significant differences in the trueness of the overall prosthetic base were found when comparing CAD/CAM CDs and CDs fabricated using conventional techniques[13]. CAD/CAM CDs showed significantly better adaptation only in the vestibular area, which, in a clinical context, could mean improved adhesion of the CD and a more intimate internal seal effect[13].

Steinmassl et al. examined the congruence of the prosthetic base with the underlying tissues for four different commercially available CAD/CAM prosthetic systems (AvaDent, Merz Dental, Whole You, Wieland/Ivoclar)[14]. They compared these bases with conventionally fabricated prosthetic bases (with long-term hot polymerization). All CAD/CAM prosthetic bases showed higher congruence with the master model than conventionally fabricated ones[14]. The findings of several in vitro studies on the better adaptation of CDs fabricated with CAD/CAM technology explain the better retention of CAD/CAM CDs observed in clinical studies[15-18].

As per the ISO standard definition, accuracy pertains to the variation in the intaglio surface of CDs created from the plaster model, while precision indicates the reproducibility of this same surface across different production methods. Accuracy denotes the degree to which a measurement corresponds to the true value, whereas precision describes the consistency of repeated measurements under constant conditions[7,19]. In this context, accuracy relates to the variation in the intaglio surface of CDs created from the plaster model, while precision indicates the reproducibility of this same surface across different production methods[7].

For this in vitro study, the accuracy and precision of complete dentures produced using three fabrication methods—CAD/CAM technology, compression molding, and injection molding—were assessed and compared. The null hypothesis was that there would be no statistically significant differences in accuracy and precision between CDs produced using CAD/CAM fabrication, compression molding, or injection molding techniques.

Material and methods

This in vitro study was conducted at the University Dental Clinical Center "St. Panteleimon" in Skopje. The conventional complete denture samples were prepared in the Removable Prosthetics dental laboratory, while the CAD/CAM CDs were fabricated at AvaDent™ (Global Dental Science Europe, Tilburg, Netherlands). The methodology was adapted from the study of Goodacre et al.[12].

Reference master model and master CAD/CAM Denture

To create the reference master model with a cobalt–chromium alloy base, an edentulous maxillary study model (Study Model KaVo™) was used due to its lack of undercuts. The model was duplicated, and three wax pyramids were positioned at key points on the alveolar ridge: over both tuberosities and along the anterior midline. The model was then invested and cast in a cobalt–chromium alloy (Figure 1). These pyramids allowed for precise superimposition of STL files from scanned plaster models and CDs during software analysis, ensuring consistent measurement of discrepancies between the same points. The master model was scanned using a 3D optical laboratory scanner (NeWay, Open Technologies, Rezzato, Italy) connected to the Exocad (Full Denture Module) software. According to the manufacturer, the scanner has an accuracy of up to 2 μm and a resolution of 5 μm. The resulting STL file was sent to AvaDent via AvaDent Connect for fabrication of the master complete denture. The denture was designed using the AvaDent Design Software and, once approved, the master CAD/CAM denture was milled from a PMMA disc (AvaDent Denture Base High Impact Puck) (Figure 2). Teeth from AvaDent's library (Ivoclar Vivadent, SR Vivodent DCL) were manually bonded into the pre-designed recesses.

The reference master model was duplicated using silicone impression material (Xantopren M Mucosa; Heraeus Kulzer, Germany) and 30 plaster models were cast: 10 for each test group. After a 24-hour drying period, the plaster models were scanned using the same 3D optical laboratory scanner (NeWay, Open Technologies, Rezzato, Italy).

Tested Groups

From the master CAD/CAM CD, a silicone mold (Optosil, Heraeus Kulzer) with a vestibular silicone key was created to fabricate CDs using two traditional techniques. An identical set of acrylic teeth, matching those in the master denture, was placed in the silicone mold and molten wax was applied to form wax dentures with the same tooth arrangement as the master denture (Figure 3). A total of 20 wax dentures were produced on previously marked and scanned plaster models. The compression-molded CDs were processed using heat-polymerized PMMA (SR Triplex Hot Acrylic Resin, Ivoclar), following the manufacturer's instructions. For dentures fabricated via the injection molding technique (Ivocap™ technique, Ivoclar Vivadent AG, Schaan, Liechtenstein), a modified PMMA acrylic material in capsules (Ivobase High Impact, Ivoclar) was used. Material preparation and fabrication were performed according to the manufacturer's guidelines.

Each of the 10 CAD/CAM group dentures was designed and fabricated based on a separate 3D scan of a plaster model. The STL scans were sent to AvaDentTM, where the dentures were milled from AvaDent PMMA discs. The same set of teeth was manually bonded onto these dentures (Figure 4).

Preparation and Scanning Protocol of the Test Specimens

After fabrication, the compression- and injection-molded dentures were hydrated in containers with distilled water for 2 days at room temperature. The CAD/CAM dentures from AvaDent arrived 2 days post-fabrication in special packaging that maintained a moist environment. These dentures were hydrated in distilled water for 1 day. Following this hydration period, all specimens were prepared for scanning by applying an anti-reflective spray (MASTERmill CAD/CAM Scanning Spray, Talladium, INC, USA). All 30 dentures were scanned using a 3D optical laboratory scanner, and the scans were saved in STL format. After scanning, the dentures were returned to containers with distilled water for 30 days at room temperature. Scanning of the denture's intaglio surface was repeated after this period. The scanning process produced 90 STL files, including 3 for each denture: q from the plaster model, 1 from the first scan after 2 days in water, and 1 from the second scan after 30 days in water.

Method for Testing denture base accuracy

The software analysis was performed at the Faculty of Mechanical Engineering, University Ss. Cyril and Methodius. To measure and compare the accuracy, a 3D surface matching software (Geomagic Qualify 12.0, 3D Systems, Informer Technologies, Inc.) was used, enabling graphical comparisons between 3D models. This software allows for the semi-automatic alignment of scanned data for precise comparison, with discrepancies represented graphically in different colors. For each denture, STL files were superimposed: the STL file from the plaster model was compared with the STL file from the first denture scan (after 2 days in water), and then the plaster model STL file was compared with the STL file from the second denture scan (after 30 days in water). The triangular surfaces of the pyramids served as reference points for superimposition of the two STL files. Deviation measurements were taken at the same points in 6 regions for all 30 dentures: 13 points along the vestibular border, 11 points 6 mm from the vestibular border, 8 points along the highest surface of the alveolar ridge, 6 points along the midline of the palatal plate, 8 points at the pharyngeal border, and 12 randomly selected points on the palatal plate. After importing the STL files into the 3D software, the comparison points were marked on the intaglio surface of the denture. Using MATLAB (MathWorks), which supports 3D graphics, the corresponding points on the plaster model were automatically identified. The software then displayed the distance (deviation or compression) between each compared point (Figure 5).

The statistical analysis was performed using Statistica 7.1 for Windows software.

For the numerical data series (vestibular border, 6 mm from the vestibular border, highest point on the alveolar ridge, midline of the palatal plate, pharyngeal border, and palatal plate), descriptive statistics were calculated (mean; standard deviation; 95% CI; minimum; maximum).

The distribution of the data was tested using the Kolmogorov–Smirnov test, Lilliefors test, and Shapiro–Wilks test (p-value). Differences between groups for the numerical data series were analyzed based on the data distribution using either Analysis of Variance (ANOVA [F/p]/LSD post hoc) or Kruskal–Wallis ANOVA by Ranks (H, p/Multiple Comparisons p-values [2-tailed]). The differences in analyzed parameters within each group, comparing the denture base measurements after 2–3 days in water versus after 30 days in water, were tested using either a T-test for dependent samples (t/p) or the Wilcoxon Matched Pairs Test (Z/p), depending on the data distribution. The accuracy and reproducibility (precision) of the tested fabrication techniques were evaluated by ranking the median values and interquartile ranges.

Statistical significance was set at $p < 0.05$.

Figure 1. Reference master model

Figure 2. Reference master CAD/CAM denture

Figure 3. Tested group—CAD/CAM complete dentures

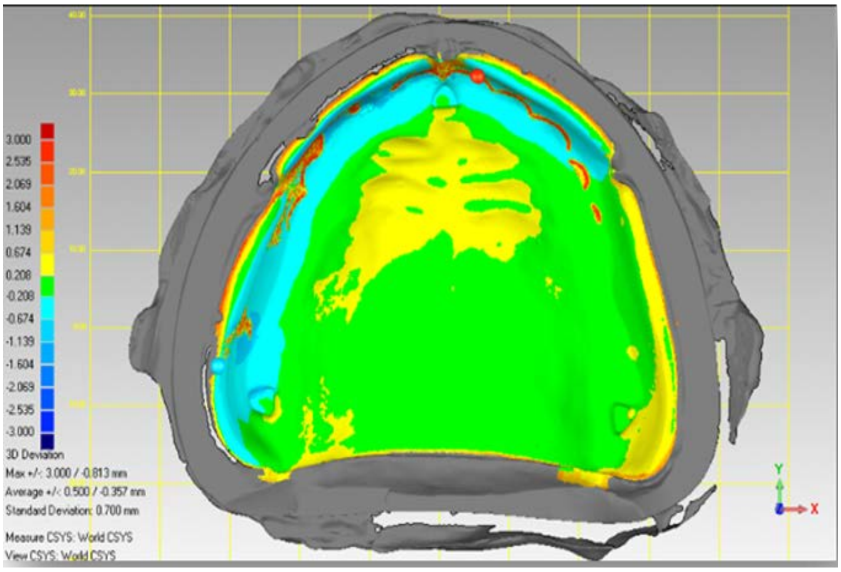

Figure 4. Superimposed STL file of the plaster model and complete denture

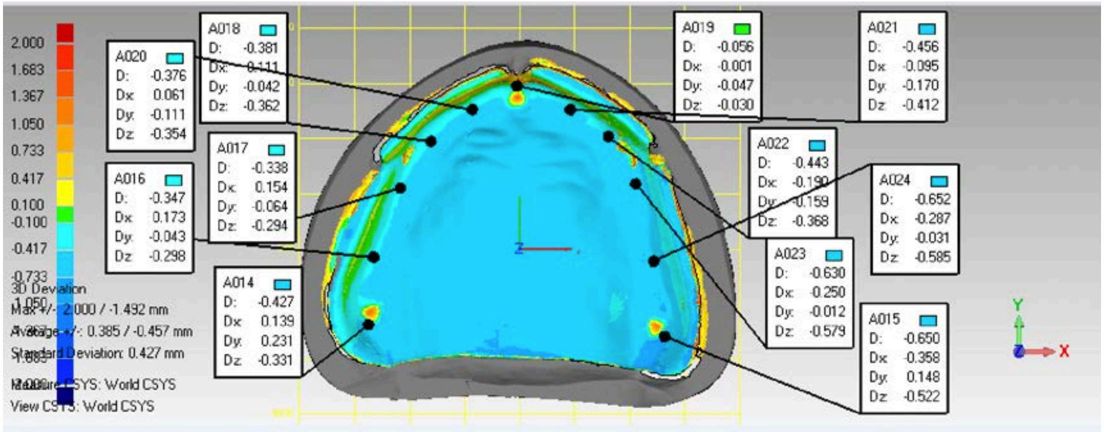

Figure 5. Color map of values of deviations between superimposed files of the plaster model and the denture base at specific points

Results

The applied statistical analysis methods were used to examine differences in the parameters within each group (intra-group) and between groups (inter-group).

The descriptive statistics obtained for the six regions in each tested group, comparing the precision of denture bases (adaptation to the plaster model) across the three techniques, did not confirm any impact of water in terms of improved adaptation of the denture bases.

Table 1 presents the descriptive statistics for all six locations across the three tested techniques after two days of denture hydration in distilled water, and Figure 6 shows the associated box plots.

Table 2 presents results based on the median and interquartile range rankings, which were used to determine the accuracy and precision (reproducibility) of the tested fabrication techniques. Ranking of the results based on median and interquartile range revealed that, in 11 of the 12 analyzed locations, the CAD/CAM technique showed the best combination of accuracy and precision among the tested fabrication techniques. The conventional technique demonstrated the highest precision only at the alveolar crest in the denture base after two days in water.

Table 1. Mean and standard deviation (Std Dev) of discrepancies of denture bases for all six locations across the three tested techniques after two days of denture hydration in distilled water

	COMPRESSION -MOLDED	**INJECTION -MOLDED**	**CAD/CAM**
Location			
Vestibular border			
Mean	-0.05	0.03	0.01
Std Dev	0.22	0.23	0.02
6 mm from the denture border			
Mean	-0.19	-0.07	0.002
Std Dev	0.26	0.16	0.01
Alveolar crest			
Mean	-0.13	0.14	-0.007
Std Dev	0.41	0.29	0.001
Midline of the palate			
Mean	0.03[a]	0.16	-0.008
Std Dev	0.50	0.30	0.001
Palate			

Mean	0.01	0.14	-0.007
Std Dev	0.52	0.26	0.001
Posterior palatal seal			
Mean	-0.02	0.13	-0.008
Std Dev	0.56	0.15	0.001

The statistically significant difference found between:
[a] $p < 0.05$ ($p = 0.04$) for compression-molded and CAD/CAM

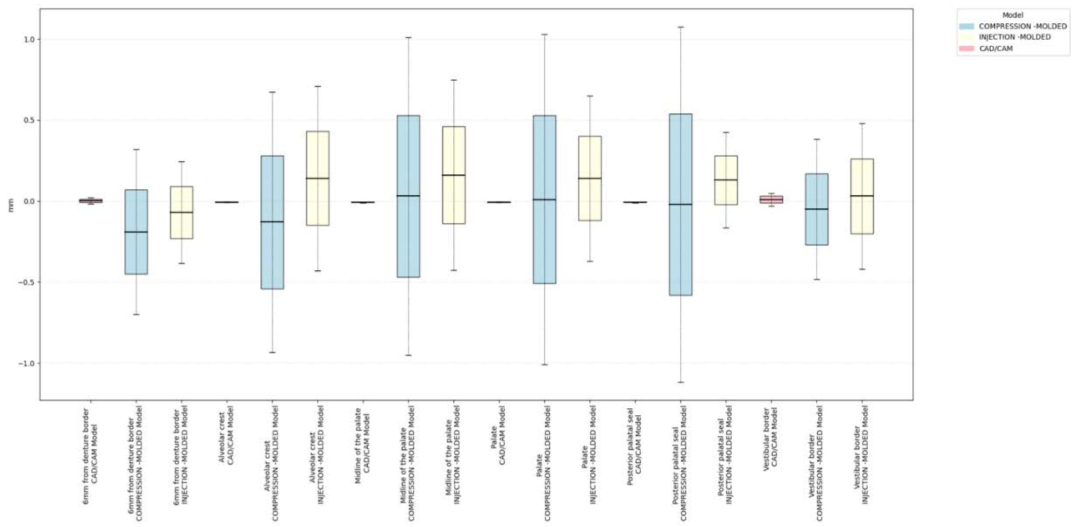

Figure 6. Comparison of mean and standard deviation values for each fabrication technique across the various locations

Table 2. Ranking by accuracy and precision (reproducibility) of the fabrication technique based on location and hydration period duration

Rank of Accuracy: Proximity to Zero (Median) **Rank of Reproducibility (Interquartile Range)**	**COMPRESSION-MOLDED** **Acc./Repr.** **Median/Quartile**	**INJECTION-MOLDED** **Acc./Repr.** **Median/Quartile**	**CAD/CAM** **Acc./Repr.** **Median/Quartile**
Vestibular border (after 2 days)	-0.028(2)/0.282(3)	-0.035(3)/0.170(2)	0.003(1)/0.009(1)
Vestibular border (after 30 days)	0.011(2)/0.340(3)	-0.126(3)/0.291(2)	0.004(1)/0.020(1)
6mm from CD border (after 2 days)	-0.121(3)/0.331(3)	-0.081(2)/0.174(2)	0.004(1)/0.004(1)
6 mm from CD border (after 30 days)	-0.199(3)/0.276(3)	-0.040(2)/0.244(2)	0.004(1)/0.009(1)
Alveolar crest (after 2 days)	-0.002(1)/0.284(3)	0.041(3)/0.191(2)	-0.007(2)/0.002(1)
Alveolar crest (after 30 days)	-0.075(3)/0.361(3)	0.054(2)/0.191(2)	-0.007(1)/0.001(1)
Midline of the palate (after 2 days)	0.199(3)/0.282(2)	0.067(2)/0.213(2)	-0.008(1)/0.001(1)
Midline of the palate (after 30 days)	0.169(3)/0.371(3)	0.033(2)/0.308(2)	-0.008(1)/0.001(1)

Palate (after 2 days)	0.178(3)/0.418(3)	0.096(2)/0.199(2)	-0.007(1)/0.002(1)
Palate (after 30 days)	0.161(3)/0.477(3)	0.059(2)/0.244(2)	-0.008(1)/0.001(1)
Posterior palatal seal (after 2 days)	0.116(2)/0.838(3)	0.132(3)/0.103(2)	-0.007(1)/0.003(1)
Posterior palatal seal (after 30 days)	0.099(3)/0.710(3)	0.084(2)/0.224(2)	-0.007(1)/0.003(1)

*Range O

Discussion

In this *in vitro* study, the accuracy and precision of denture bases fabricated with CAD/CAM technology were compared to those fabricated using compression and injection molding techniques. Compression molding is widely used for denture fabrication due to its simplicity and relatively high accuracy, making it the gold standard for comparison[20]. Among conventional denture fabrication methods, injection molding was also selected for this study as it is recognized for its ability to effectively compensate for the contraction of PMMA[21–24]. For both conventional and injection techniques, PMMA acrylic material from the same manufacturer (Ivoclar Vivadent, Schaan, Liechtenstein) was used to ensure that the observed characteristics depended solely on the fabrication technique, thus eliminating material composition as a variable.

The sample size for each group (n = 10) aligns with similar in vitro studies in the published literature[12,24,25]. To maintain consistency, the compression- and injection-molded samples were produced by an experienced technician with strict adherence to the manufacturer's protocol. Each sample was fabricated as a complete denture with teeth, which allowed for a direct correlation between dimensional changes in the denture bases and the fabrication technique. This approach is crucial, as Barco et al. demonstrated 45% greater space under a denture with teeth than under a denture base alone[26]. Keenan et al.[27] further indicated that testing dimensional changes in acrylic samples of different shapes, such as plates or denture bases without teeth, can yield different contraction patterns in PMMA material.

Dimensional accuracy and precision were assessed at 2 days post-fabrication and again after 30 days. Immersing the dentures in distilled water was chosen over artificial saliva products, as these products—while containing the inorganic components of human saliva—lack saliva's natural viscosity and do not fully simulate the conditions of the oral cavity. According to some authors, water storage induces expansion in denture bases through water sorption (both adsorption and absorption), which separates macromolecules and expands the material[28]. This expansion offsets the polymerization shrinkage of acrylic materials, improving the fit of the denture base to the underlying tissues[29].

Descriptive statistics for the six regions in each group, comparing the denture base fit with the plaster model over 2 days and after 30 days, did not demonstrate a significant impact of water on denture base adaptation after extended immersion. Clinically, this suggests no substantial improvement in the fit of CDs with prolonged wear in the moist environment of the oral cavity.

In the group of CDs fabricated using conventional techniques, comparing the parameters for each region between 2 days in water and 30 days in water showed dimensional changes across all regions, although none were statistically significant. Goodacre et al.[12] posited that a 24-hour water immersion period suffices for hydrating conventional CDs, with no expected improvement from more prolonged water exposure—a conclusion supported by our findings here.

For the CAD/CAM group, no significant differences were found in measurements after 2 and 30 days in water, potentially affirming the manufacturers' claims that CAD/CAM acrylic blocks, due to factory polymerization, are denser, highly cross-linked and, thus, highly hydrophobic[30–32]. However, in a study by Srinivasan[13], improved accuracy in the denture bases of CDs fabricated with CAD/CAM, injection, and conventional techniques was observed after 21 days in artificial saliva, when compared to measurements taken immediately after fabrication, although this improvement was not statistically significant. After 21 days, conventional CDs exhibited the highest base accuracy[13]. The study indicated variations in the accuracy of the intaglio surface in CAD/CAM CDs. These findings may be influenced by the size of the cutting tool, which can create a slightly rougher denture surface. The micro-rough intaglio surface of CAD/CAM CDs is not a disadvantage in a clinical context; on the contrary, these micro-spaces for saliva can provide additional adhesive strength for CDs[13].

The median and interquartile range figures helped in the assessment and ranking of the fabrication methods. The median value demonstrates the accuracy and consistency of CD base adaption. At the same time, the interquartile range reflects the precision or reproducibility of the technique—essentially, the ability to reliably produce a high-precision denture base each time the technique is applied. When evaluating the efficacy of a fabrication technique, a median value close to zero and a narrow interquartile range are ideal[12].

Regarding the ranking based on the medians and interquartile ranges across all 12 evaluated parameters, the CAD/CAM technique demonstrated the best overall combination of denture base accuracy and reproducibility in 11 of the 12 parameters analyzed (Table 2), while the compression molding technique showed the highest accuracy on the alveolar ridge crest after 2 days in water. Notably, the ranking according to the median value for accuracy on the alveolar ridge surface (after 2 days in water) differed from the conventional technique's mean value for this same parameter in inter-group comparisons. In particular, the standard deviation for measuring this parameter in CDs produced with the conventional technique was 0.41 mm, that for the injection-molded CDs was 0.29 mm, and that for the CAD/CAM-manufactured CDs was 0.001 mm. When comparing mean values across groups, measurements at identical points can be analyzed and compared, while the median value provides a generalized overview of results[12].

The interquartile range for the CAD/CAM technique was the narrowest of the three techniques, encompassing all 12 evaluated parameters and ranging from 0.001 to 0.009. This narrow range positions CAD/CAM as the most reproducible technique for denture base fabrication. The injection technique followed, with the second-narrowest interquartile range across all parameters, making it the second most reliable in terms of reproducibility. In contrast, the compression molding technique had the widest interquartile range (from 0.276 to 0.838). These findings are consistent with the results of Goodacre et al., who compared four fabrication techniques and noted similar performance variations[12].

The narrow range of median values observed in this study (from -0.199 to 0.199) has no clinical significance and indicates that all three techniques achieve clinically acceptable levels of accuracy. Notably, the master model used in this study features idealized alveolar ridges, that is, without undercuts and with a shallow palatal vault. In cases where the palatal vault is steeper and deeper or undercuts are present, polymerization shrinkage would likely be more pronounced when using compression and injection techniques. For these more complex ridge forms, CAD/CAM technology could be expected to achieve even greater precision in the fit of denture bases; however, this assumption warrants validation through further research.

Conclusion

Based on the results obtained, the null hypothesis outlined in this study was rejected. According to the ranking of the three techniques based on mean values and interquartile ranges, the denture bases of complete dentures produced using CAD/CAM technology demonstrated superior accuracy and precision to those produced using compression and injection molding techniques. The CAD/CAM method obtained the highest reproducibility, indicating consistent precision in CD fabrication. In contrast, the conventional technique exhibited the most significant variability in terms of the precision of the denture bases.

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Conflicts of Interest

The authors declare that they have no conflict of interest.

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