

Fitness Evaluation of Poly-Ether-Ether Ketone Removable Partial Denture Fabricated by Two Different Techniques: An in-vitro Comparative Study

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Abstract— Introduction: The purpose of this study was to evaluate the fitness of the removable partial dentures peek framework made using two distinct fabrication techniques (fabricated by milling via CAD-CAM and injection molding technique). Materials and Methods: A total number of 18 samples were used. The specimens are categorized into two major groups., I and II are each composed of PEEK RPD frameworks for a maxillary class III modification 1 Kennedy classification. Group (I): Frameworks produced by milling via CAD-CAM technique.Group (II): Frameworks produced by injection molding technique. Results: For overall framework adaption, group II(produced by injection molding technique) provided the lowest value (least fit), whereas group I (produced by milling via CAD-CAM technique) provided the highest value (best fit). Conclusion: Within the limitations of this short-term study, it was concluded that: The RPD frameworks created using the direct CAD/CAM technique had higher fitness values than those created using the indirect technique. The direct technique displayed a more uniform distribution of the color map, whereas the indirect technique displayed greater pressure areas in the anterior and posterior strap locations.

Keywords: 3d printing / partial dental / peek.

Introduction

RPDs are considered an economic and good treatment option compared with most costly alternatives like dental implants. The primary components that contribute to the success of an RPD are thought to include proper design, component selection, suitable materials, follow-up, and patient acceptability. Acceptable fit is necessary for an RPD to operate properly. (1)

Digital technology is evolving quickly, and it is being used to design and create prosthetics for everything from a single missing tooth to an entire arch.

With computer-aided design and computer-aided manufacturing, detachable dental prostheses are now being made using digital technology. (2)

Along with lowering the need for dental laboratories, CAD/CAM technology has improved the quality of fit of RPDs, improving efficiency and manufacturing results. The polymer or metal can be directly machined into RPD frameworks. Frameworks made of resin and wax can be 3D printed, and then processed using conventional fabrication techniques. (3)

PEEK has been reported that it can be used to make RPDs instead of base metal alloys in constructing RPDs. The connection between CAD\CAM techniques, injection molding techniques, and thermoplastic resin material is The goal of this project is to determine which suitable technique can be used to achieve the most acceptable fit of the PEEK removable partial denture framework. (4)

The accuracy of fit of the RPD frameworks must be optimized to achieve maximum function, and esthetics and remain biocompatible.

Recent techniques involve scanning the removable prosthesis and the cast, saving the scans as stereo lithographic images in the STL file format, superimposing the two STL files of each scan using surface matching software, and then calculating the distance between the cast and the framework by slicing the scan data. (5)

This study aimed to evaluate the fitness of the removable partial dentures peek framework made using two distinct fabrication techniques (fabricated by milling via CAD-CAM and injection molding technique).

Materials and Methods

A standard stone model (Elite Rock, Zhermack gmh Deutschland, Italy) of maxillary Kennedy class III modification I was used where the second premolar and first molar were on one side, and both central incisors were missed and this area represented the ridge and the vault.

Grouping of the samples:-

A total number of 18 samples were used. The specimens are categorized into two major groups., I and II are each composed of PEEK RPD frameworks for a maxillary class III modification 1 Kennedy classification.

1- Group (I): 9 Frameworks produced by milling via CAD-CAM technique.

2- Group (II): 9 Frameworks produced by injection molding technique.

Steps of Digital Design

A-scanning of the stone cast

- The cast was scanned using a digital optical light laboratory scanner (Valletta 3,0 , exocad , Germany) to get a virtual model.
- The cast was attached to the scanning table and a screw was tightened around the cast to ensure that it was placed in the correct position. The cast position was adjusted so that the top of the cast was facing the light source.
- Click on the Start scan button on the software of the scanner was done.
- The cast holder was rotated automatically to the scan cast from all directions. After that, the output file was saved as an STL file format representing the virtual cast.

B-Digital surveying of master cast using Exocd software:

The output STL file of the scanned stone cast was imported into the Exocad RPD design software* where the digital design was done as follows:-

- a) Selection of restoration type
 - Restoration type was selected during case entry.
 - For our study, the restoration type was removable partial denture.
- b) Automatic surveying and block-out:-
 - The most crucial step in this process was inspecting the cast to find both good and undesired undercuts.
 - The CAD software's auto survey capability made it simple to complete the surveying process.

The scan made it simple to see where and how deep the undercuts were.

The undercut depth range in this software was 0.25 mm, 50mm, and 0 0.75mm It was measured automatically and was colored according to the depth of the undercut ranging from yellow, light orange, and dark orange in red.

All undercuts were blocked using the automatic block-out function. The software has a block-out setting range of 0 to 5, and a 5 block-out angle was used.

The block-out was removed from the desirable undercuts to be used on the abutment teeth using the trimmer button.

The relief button was used to make relief in the area of the gingival margin crossed by the minor connector.

Selecting the design of the RPD framework

A) Design of the major connector

- The selected major connector was the anteroposterior palatal strap (ring design) and by using the mouse, the outline for the major connector was drawn on the virtual master model.

- The ring inside the major connector was drawn after the outline of the anterior and posterior strap was done using a button called to draw a window inside the major connector.

- The outline and the dimension of the ring were adjusted by moving the mouse until the desired outline was obtained. The thickness of the major connector was adjusted to 1.5 mm thickness.

B) Selecting the design of the clasps

The location of the clasps should be such that they contact just the right amount of undercut to be effectively retentive. Aker clasps were used for the first premolar abutments with a design produced by choosing the best location of the undercuts.

The minor connectors, the rest seats, and the guiding planes needed to be drawn in once the clasps were applied.

C) Designing the external finish line

The external finish lines were added by clicking the button specially for its design.

Inadvertently produced rough or sharp edges were eliminated during the design process.

Once the RPD design was completed, it was inspected for any errors during design or missing parts and there was an option inside the design software to inspect the virtual framework alone without the cast.

After the design was completed it was saved in STL file format. This STL file represents the virtual framework design.

. Fabrication of the virtual framework

There were two separate fabrication methods used to create the virtual framework:-

.1- The first technique (Direct CAD/CAM) (group I)

The digitally designed framework was fabricated from peek (Brecam biohpp blank disc, bredent, Germany) using CAM technology; direct milling technology (Direct CAD/CAM), and represented group (I).

.2- The second technique (Indirect CAD/CAM) (group II)

The CAD-designed framework was 3D printed from castable resin wax Biohpp granulates, bredent, Germany framework and fabricated from BIOHPP using the injection molding technique (Indirect CAD/CAM) and represented group (II).

A-Fabrication of PEEK RPD framework for (group I)

The digitally created framework's STL was loaded into the program. This software was used to virtually calculate and evaluate the position of the virtual framework in the disc space before starting milling procedures. Once the calculations were performed, we needed a PEEK disc of 98mm diameter and 20 mm height and the estimated milling time was about 6 hours. The framework was ready to start The milling procedure by clicking on the Start button.

PEEK disc was inserted into the disc holder and was securely tightened to allow the specially designed Brecam BIOHPP bars to star. The milling machine used was the ARUM milling machine ARUM (Arum, Korea). The machine then machined these digital patterns into a 3D PEEK structure using peek blank discs. After 6 hours of milling, the final framework inside the disc was milled. peek block was safely removed from the disc holder inside the milling machine and the finishing and polishing procedures were done. the final framework on the master cast, the framework was ready to complete the following procedures.

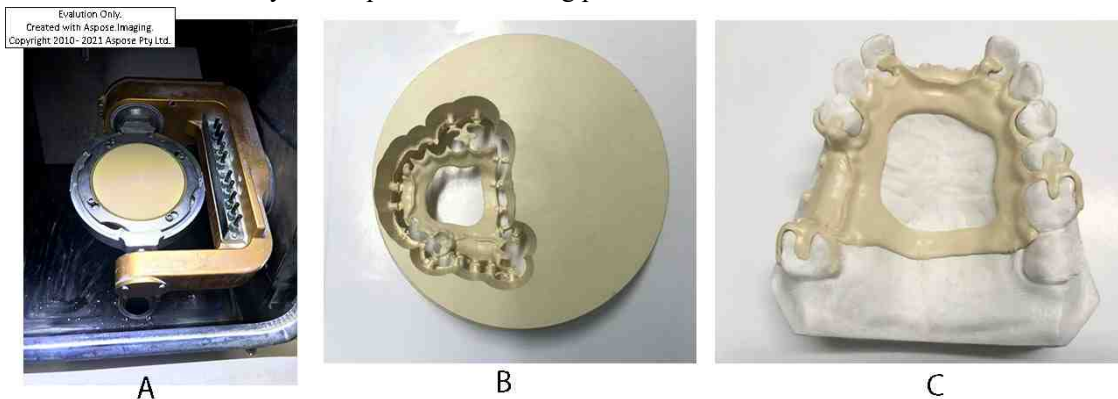


Figure 1 shows the fabrication of the milled framework.

B- Fabrication of PEEK RPD framework for (group II)

The fabrication of the RPD framework for group II included two steps where the resin pattern was first produced using 3D printing, then the framework was fabricated from PEEK using the injection molding technique through a thermo press machine.

The pieces for the 3D printed objects were made from a photo-curable liquid resin which was cured when exposed to light by a photopolymerization method. The resin surface area was scanned across at a 45-degree angle throughout the printing process.

The part was constructed layer by layer, with a light curing system scanning each layer and an elevation mechanism elevating steps after each layer to control the process.

The Stl file by hyper dent program was cut the design into small slices which have this specification.

Build Tray calibration was done to ensure perfect alignment of the platform with the tank surface which as a result provided optimum prints. The machine calibration option was selected

from the home menu. After the smart tray system stopped the ball joint screw was tightened to the maximum, making sure that it was properly aligned in both vertical and horizontal directions. The tank was cleaned with alcohol and then left to dry for 5 minutes. The photosensitive polymer bottle was shaken for at least two minutes before opening. A suitable amount of resin was placed in the tank, platform. The machine cover was closed to protect resin from other light sources that can polymerize. The printer's software (Printer, ANY Cubic photon, any cubic, china) imported the framework's STL file. The file was imported in an arbitrary orientation. Adjustment of framework orientation was performed using the mouse and Move button in the software. After the orientation was adjusted in the build, the addition of supporting bars was done to support print material during the printing process.

-The Save button was clicked to save the STL file of the framework with the supporting bar and position to the virtual platform and was ready for printing.

The add option was pressed to add STL file of the framework with support.

The resin profile was selected with which the file would be printed the profile corresponding to the resin type used and it was RPD framework.

- Finally, the Submit option was selected and the 3D printer started printing layer by layer and the light source polymerized it layer by layer. The light emitting diode (LED) indicator light was turned green when the printing process had been finished. The smart tray system was removed to get the printed part, Washing of the printed framework with alcohol to remove any residual resin on the printed framework. Post-curing cycle: The printed framework was placed inside the curing unit for a post-curing cycle of about 30 minutes through continuous curing. The support structure was removed from the printed framework by applying gentle pressure to the point where the support was connected to the printed framework. The supporting bars attached to the framework were removed with stone burs and the final printed framework was checked. Putting the printed framework on the stone master cast was done and it was accurately adapted.

The 3D printed framework was converted to PEEK using the injection molding technique and thermo-press system. Spruing of the framework. was made by The attachment of sprues to the framework. The manufacturer's instructions were used to determine the location and geometry of the sprue formed, as a sprue that was directed horizontally gave rise to some smaller, auxiliary sprues. The sprue was attached to various areas of the resin pattern and was attached securely with molten wax.

The sprue dimensions were critical, and the manufacturer's directions were followed exactly. To facilitate contact with the aluminum cartilage through the primary entrance hole in the flask(Thermopress flask, bredent, Germany) for the injection procedures, prefabricated sprue wax of 25 mm thickness was attached to the wax pattern.

This study employed the denture injection flasking process. A special flask with one opening entrance for the injected material that was appropriate for the thermopressing process was employed.

The injection aperture of the customized flask was positioned roughly 2.5 cm away from the resin structure. Hard dental stone investment and die stone molding that had been blended following the manufacturer's instructions were placed in the lower portion of the dental flask. To avoid trapping air The wax pattern and the sprue were placed in position horizontally after coating one side with vacuumed creamy consistency stone material to to avoid trapping any air. Secured The two halves of the flask by fully tightening the screws. Another vacuumed stone mixture layer was poured into the upper half of the flask by using the vibrator to avoid trapping any air. when the stone material had set, after 45 minutes, it was ready for the boil-out step. The resin was eliminated using a wax extraction unit furnace (Bifa, Electrotherm, Italy) for 20 minutes at 200 C The flask was then opened, and all of the wax was removed using detergents and boiling water. The mold surfaces were left to dry for 30 seconds, and one layer of suitable separating medium for thermo-pressing purposes was added to the mold surface and left to dry overnight and cool.

By using a press injection molding system the injection molding was performed in a commercially available injection molding machine (2 press injection, bredent, Germany). The injection time and pressure to thermo-press the peek were according to the manufacturer's instructions. The manufacturer stated that the injection system was designed. To perform the framework injection technique, a 20g peek granulate cartridge made of aluminum was used. Once the preheating temperature was set to the ideal level, the cartridge was put into the heated chamber.

The parameters of the injection machine were set as follows: A 20-minute pre-injection period during which the material was kept at 380°C (the melting point); a 2-minute post-injection period during which the temperature was kept at the appropriate level of 220°C; a 60-minute cooling period; and an injection pressure of 4 bar.

Within 60 seconds, the peak molten material was pumped at a pressure of 4 bar into the mold cavity. The injected PEEK polymer required five to six hours to cool.

The injected molds were nevertheless left overnight to allow the bench coating to slowly reach room temperature.

By loosening the screws that had been tightened, the cold flask was deflated, and the framework was then detached from the investment stone material.

A disc bur was then used to remove the sprue at a speed of 300 revolutions per minute (rpm).

The completed framework edge that linked to the sprue utilizing sandpaper on a grinder and polisher at a 400 rpm speed. To remove any investment material from the sample surfaces, the framework was submerged in the plaster cleaning solution for 15 minutes. The framework's smooth surface was finished and polished. the final framework of the stone master cast was ready to complete the following procedures.

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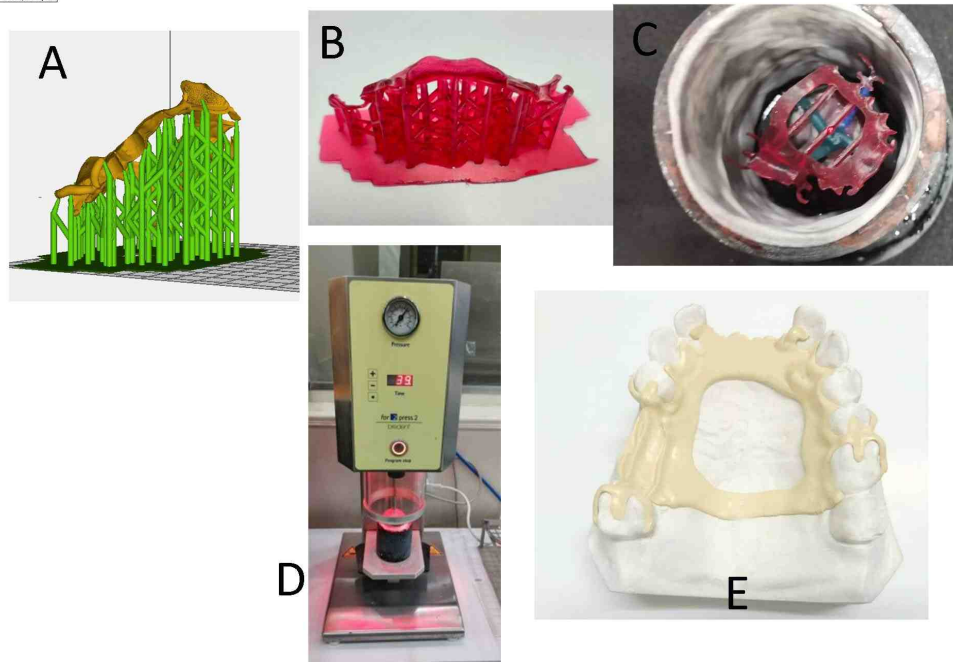


Figure 2 shows the fabrication of the CAD CAM indirect framework

a) Scanning procedure:

-Anti-glare spray was applied to the reference cast's teeth before it was scanned in a lab using an up3d scanner(up3d scanner, UP300e, China. and the output STL file was saved as a reference STL for measurement procedures. The clay was fastened to the lower edge of the posterior palatal strap and used to secure each framework of the two techniques to the scanning table. Then the scanning procedure was performed. The parts marked in red were the parts that needed to be scanned. Each framework's output STL files were saved into the computer as STL files bearing the name of each approach.

b) Surface matching and superimposition:

A surface matching software program imported each STL file of each framework together with the STL file of the cast.

Each framework was rotated into x, y, and z virtual planes using the transform button to facilitate the matching process. The reference cast was also rotated in the desired plane.

A new screen having tool options was opened using the best-fit option in the software was performed. Three START and END buttons were used for the surface matching between the frameworks and the matched of the virtual original design. Fit using the selected points button was selected the both STL files of the reference cast and framework were superimposed correctly.

This final matched position of the superimposition was saved to be the reference for measuring procedures. These procedures were performed for each framework of both techniques separately. Both STL files of the virtual design and framework were superimposed correctly using the same button.

Evaluation of Fitness:

The average deviation of each final framework from the original design was measured using the software.

The automatic accurate fit was performed by the pressing exact fit.

It is important to remember that when analyzing fit accuracy compression of the tissues is indicated by negative values (blue color) and that a misfit with space from the reference cast resulted in a positive value (red color),

Therefore, finding the mean value might have balanced the compression and spacing zones in some areas reported An optimum compromise between a tight fit and painful injury, which can only be anticipated with compressions beyond 0.5 mm, may be found at a median compression of 0.1 mm.

The color map appeared on the left side of the screen with a color scale indicating the distance between the superimposed framework and the virtual design.⁽²⁾

Reading of average distance appeared in the window under the color map. The color was in the range of green in all frameworks indicating high trueness values. The positive critical values were in red indicating areas where there was a great deviation or positive errors.

The dark blue indicates negative errors The average distance was in microns.

These procedures were performed for each framework of both techniques.

The major connector areas include:

- A. The anterior strap area points were chosen as one of the main connecting sites.
- B. The sites in the anteroposterior (A-P) strap area were chosen.
- C. The sites in the strap area were chosen.

In each location where the measurement was made, points were chosen.

The framework fitting surface was chosen to be colored according to the deviation distance from the master cast, and the measurement was carried out using the software's "best fit" option, which allows a color mapping of the scene.

The color scale was adjusted to have a zero scale and maximum critical scale "+ 0.5" and minimum critical scale = "- 0.5" where zero indicates no space present between the reference cast and the framework⁽²⁾

Positive values toward "0.5" indicate space between the reference cast and the framework. Negative values indicate pressure or impingement of the framework on the reference cast. The color scale was a level scale where red was the positive critical and dark blue was the negative critical. The dark green was the zero space.

Every part of the scale was presented by histogram which showed the values of each color next to the colored fitting surface. The values of each area were selected where the points of measurement were shown by pressing on each point and a label represented the value label expressed the virtual distance in mm in the x, y, and z planes and also the average distance in millimeters (mm). each point was shown. This position of the points was saved after measurement was performed for the first case and was used as an overlay guide where we selected through it the same points of measurement and then hid it again using the hide option. The measurement was performed at points for each framework of both techniques in the same way. The measurement was performed five times and the error was about 0.02.

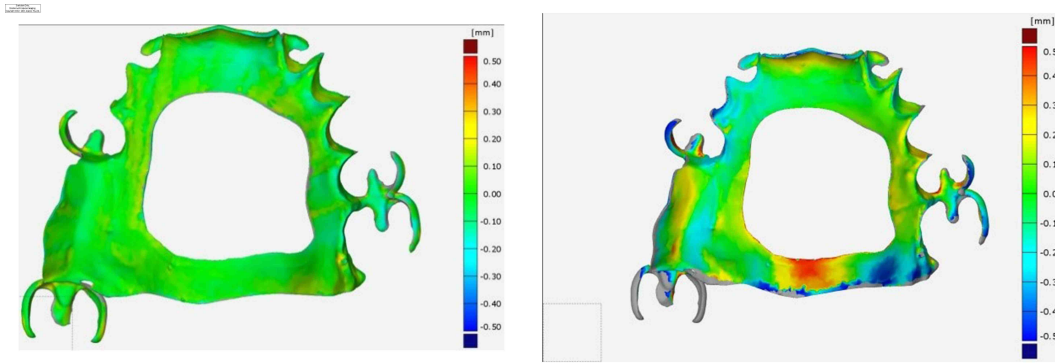


Figure 3 shows the color map of the fitness accuracy.

Data were gathered, and collated, and statistical analysis was performed

Results

After data was tabulated and imported to statistics software (SPSS version 26, IBM, USA), the Shapiro-Wilk test was used to test normality. The test showed no statistical significance difference (p-value > 0.05) and that indicates normal data distribution.

All frameworks' deviation mean and standard deviation values were expressed in mm. t-test analysis of the variable between the two groups revealed a statistically significant difference between both techniques' p-values (<0.05).

Group Statistics

Fitness	group	N	Mean	Std.Deviation	P -value
	injected	9	.1900	.01225	
milled	9	.1256	.03321		

The mean value for the milled was 0.1256 \pm 0,0332 while it was 0,1900 \pm 0,01225 for the injected as shown in the figure 27:-

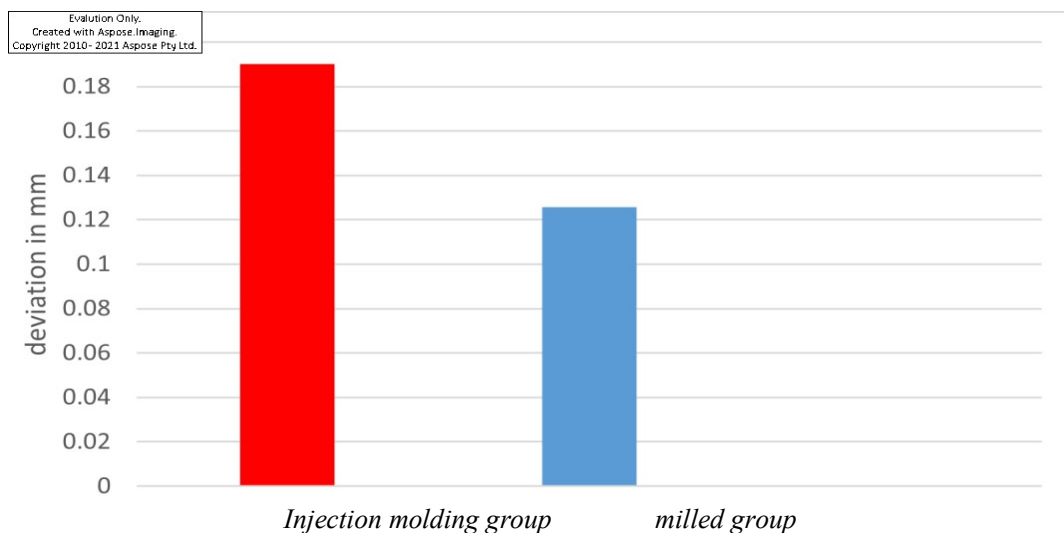


Figure 4 shows the mean value for the direct and indirect technique

For each framework in each group, the distances in millimeters (mm) between each framework and the reference cast were determined. Close contact (no gap) was defined as a gap between 0 and 0.05 mm, while a clinically acceptable fit was defined as a gap between 0.5 and -0.05 mm.

Differences between the frames of both approaches and the reference cast are depicted in color maps of the surface.

Yellow to red areas denote a void between the reference cast and the RPD framework.

Blue areas denote areas where the cast and structure are under pressure or compression.

A green-colored map would demonstrate an optimal adaption of the framework to the cast, representing the ideal framework fit.

Comparison of the total mean accuracy of the two techniques:-

The mean distance between all the frameworks and the reference cast for the direct technique was 0.1256 ± 0.0332 and was -0.09 ± 0.05 for the indirect technique. A statistically significant difference in the precision of fit between the direct and indirect CAD/CAM procedures was found using a T-test analysis of the variance between the two groups (P value 0.05). An independent sample t-test was utilized to compare the means of the two groups because the data were normally distributed.

As shown in Table 3, group 1 deviation has a more statistically significant difference than group 2 (p-value <0.05). For overall framework adaption, group II provided the lowest value (least fit), whereas group I provided the highest value (best fit).

DISCUSSION

For the restoration of partial edentulism, many treatment options are available, including implant-supported crowns, fixed partial dentures supported by implants, detachable partial dentures, and fixed partial dentures supported by teeth. (6)

There are many different reasons to use removable partial dentures (RPDs) for treatment. Because of the benefits that detachable prostheses offer. (7)

This study was conducted using only the same model with the same teeth preparation for more standardization and to eliminate the effect of the fit difference between one framework and another one which may affect the accuracy of fit. All measurements were performed for the two groups on the same model. (8)

A maxillary cast was selected for this study because the frameworks are of relatively high weight which annoys most patients and may compromise retention. Using new polymer-based frameworks enabled the relatively low-weight denture acceptable and tolerated by most patients especially if used in maxillary. (9)

A maxillary cast Kennedy class III modification 1 was selected so that we can study and evaluate the fit of RPD frameworks in both the anterior region of the teeth and in the posterior one also because there are a lot of abutments, clasps and rests that may increase the retention, stability fitness of the RPD and because of a broad area of coverage and it was easy to evaluate fitness. (10)

PEEK was chosen as the RPD framework material in this study because of its excellent mechanical capabilities as a denture foundation material and the clasp's potentially strong retentive force at deeper tooth undercuts. (11)

PEEK can be utilized by patients who detest the denture framework and retentive clasps' metallic taste, weight, and unsightly metal display. (12)

Additionally shock-absorbing while being chewed, PEEK frameworks offer a high abrasion resistance. The subtractive CAD-CAM manufacturing technique is based on the automatic transfer of

CAD model software into a tool path for milling by (a CNC) machine. According to the scanned data, digital surveying was accomplished virtually to determine the suitable path of insertion and removal and the amount of undercut through computation to determine a more accurate way than manual surveying. (13)

The choice of the CAD/CAM technology in the design and processing of the framework was because several studies reported acceptable clinical outcomes and a good to excellent fit with CAD/CAM RPD frameworks, Due to the lack of a refractory model, CAD-CAM technologies allow to cut the time of the laboratory procedures by roughly 60-70% or manual waxing up of the framework and this lead to improved quality assurance issues and improved fit. (14)

In this study, based on the creation of resin framework in the Indirect technique it has many advantages like being able to be clinically and modified before conventional processing using the lost wax technique. Resins were recommended to overcome the problems of wax as pattern forming material. Resins offer higher strength, dimensional stability, and lower flow than pattern waxes and non-residue burnout stated that the wax is by no means the only potential cause of inaccuracies in castings. Significant distortion of frameworks occurred. A combination of dimensional variations in the casting wax and the refractory cast may have contributed to the consequent fit problems. This issue was resolved by using 3D-printed resin patterns. (15)

The (MI) is the manufacturing technique that is most frequently utilized. However, (RP) has recently grown in popularity and now offers some novel techniques. The application of (RP) as a manufacturing process may result in additional process simplification, offering a method that is less expensive and time-consuming and eliminates tool wear. (16)

Since RPDs constructed of base metal alloys have a high rate of tool wear during milling, this method has shown to be uneconomical. Therefore, before employing the traditional lost wax casting approach, the economical application of (MI) requires the creation of PEEK-based dentures or wax milling. Another issue is the material loss, unlike RP, which depends on constructing layer by layer. However previous studies showed that a milled framework could produce a better fit than other techniques. (3)

The five-axis milling machine was employed in this investigation because it can mill undercuts in all directions and restorations machined with a 5-axial milling unit have more precision than those milled with a 4-axial milling unit. (17)

The cost of the RPD prepared from the 3D printed framework is now roughly equivalent to those prepared using the conventional method thanks to the utilization of 3D printing services. Additionally, 3D printing technology is significantly more affordable than alternative rapid prototyping methods. (18)

The designed frameworks, were first 3D printed, to tried it in the model to check all items, and all required modifications and to avoid unexpected faults before working on peek because It is impossible to adjust the design after construction or estimate the retention capacity of peek removable partial dentures after manufacturing. (19)

Advancements in digital technology have provided the basis for digital evaluation of the fit and trueness of the prosthesis. (20)

With the help of superimposition, it was possible to gather a large number of data points and determine the best possible match between the master model and the RPD frameworks, which makes the current methodology new. Additionally, the use of color mapping made it easier to spot portions of the frameworks that were overworked or improperly fitted. (21)

A blue light laboratory scanner was used for scanning the frameworks and the reference cast to perform the evaluation procedures. Because the materials used to form the gingiva or scan body are frequently transparent and short-wavelength blue light is not transmitted, it is reflected from the surface, making blue light the best scanning method for making the projected border readable. Blue light scans are less sensitive to heat than white light scans since they employ LEDs. The light source is more reliable and lasts a lot longer. More significantly, a scanning device that uses structural blue light can obtain a good reading inside a well-lit space. (22)

The components of the partial dentures were discovered to fit the abutment teeth too loosely, which made dentures easy to dislodge. According to Frank et al., patients who were dissatisfied with their RPDs (76%) cited lack of fit as the primary factor. Numerous occlusal rests in their matching rest chairs have little to no touch with the floor, according to earlier investigations. (23)

There is a dearth of scientific evidence supporting the RPD framework's precision of fit and veracity after fabrication using CAD/CAM processes. Compared to CAD/CAM machining or prototyping, very few studies have examined the fit accuracy of RPD frameworks produced using different approaches. (14)

The direct CAD/CAM technique has greater trueness values than the indirect technology, according to the trueness and fitness outcomes of this study. This can be explained by the fact that the direct technique preserved the stippling whereas the indirect technique lost it due to the finishing and polishing of the frameworks. This is further supported by the color map of the indirect technique's veracity, which displayed red and yellow regions in the polished surface's stippling areas. This could potentially be attributable to inaccurate digital scanning of entire arch cases or to software-induced faults made when processing STL files. (24)

This is further supported by a study that found the lowest distortion and maximum precision in RPDs produced utilizing direct CAD/CAM techniques. The high-quality surface finish produced by the milling procedure, which makes decisive polishing easier, was used to explain their findings. (11)

The color maps used in this study showed how the two strategies created different levels of adaption. It is obvious that the direct CAD/CAM technique created the most uniform adaptation of the framework to the cast, and statistical analysis of the measurements supported this finding even though no processing technique produced a green color map. (25)

The direct CAD/CAM processes automatically supplied this compression, but clinical research is still needed to verify this theory. This could be ascribed to the thermo-pressed frameworks' expansion, which caused compression in some places along the entire framework and created a snug fit. These explanations are supported by a study that demonstrated how the PEEK's dimensional accuracy varied depending on the mold temperature, specimen depth, and expansion of about 33% from the original dimension of 0.8 mm, and by about 32% in the case of the 1 mm depth of the thermopressed specimen at 200 °C. (26)

Another illustration may be due to the vertical position of the framework during scanning which makes it more vulnerable to distortion. To minimize this source of imprecision as well as the framework was scanned from various angles. (27)

As a result, both two RPD framework groups offer a close to adequate fit that is clinically

acceptable. These results may be due to the elimination of various conventional fabrication procedures used in RPD framework construction that may cause misfits as reported in the literature. These findings support earlier research that found direct and indirect CAD/CAM-fabricated frameworks show adaptability that might be used in the clinical setting. (21)

Conclusion

We can draw the following conclusions from this in vitro study's limitations and the data it produced:
1-The RPD frameworks created using the direct CAD/CAM technique had higher fitness values than those created using the indirect technique.

2-The direct technique displayed a more uniform distribution of the color map, whereas the indirect technique displayed greater pressure areas in the anterior and posterior strap locations.

3-The use of the injection 2 press system combines the benefits of CAD/CAM technology (saving time, making it simple to make design changes, controlling the shape, thickness, and configuration of every component, and identifying the insertion path) with the cost-effective material saving of injection pressing, which prevents the waste of expensive PEEK materials that occurs with milling techniques.

Our research indicated that a milling framework may produce a better fit than other approaches.

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