Figure 4: Showing silicon putty mold for wax denture bases, in which then used for fabrication of heat-cure acrylic denture base.

Finally, ten 3-D printer denture bases had been made up with a 3D-printable material (soft acrylic optiprint; dentona) using a DLP-based printer (versvs 385; MICROLAY). Each building layer was 100 mm thick, and the printer's light source (a light-emitting diode) had a wavelength of 385 nm following the manufacturer's recommendations, the denture bases were cleaned with ultrasonics in isopropyl alcohol for 10 minutes and then treated with an ultraviolet light post polymerization machine for 15 minutes (Figure 5) [9].

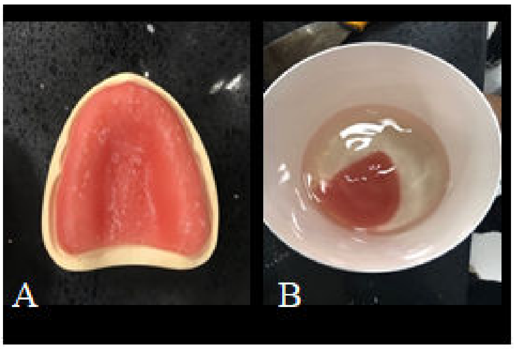

Figure 5: A) 3-D printing Denture bases were created utilizing a DLP-based printer and a 3-D printable material (soft acrylic optiprint; dentona); B) 3-D printer denture bases cleaned in isopropyl alcohol for 10 minutes.

All denture bases were properly hydrated for 24 hours, at that point softly sprayed with anti-glare spray (3-D laser checking anti-glare shower; Erum-YOONWON) with a particle diameter of 2.8 µm on average, after processing the tissue surfaces of each denture were scanned using (vinyl 3D scanner; smart optics), resulting in STL files for the tissue surfaces of each denture (Figure 6).

Figure 6: denture base with its corresponding cast after cleaning and finishing.

Using the (Exocad in-lab DentalCAD) software, the STL files of each denture were overlaid on the STL files of the matching preparation cast utilize this software, there were measurements taken at 60 points for each of the 30 dentures using an overlay guide in which it represents one of the best fit denture base with 60 points drawn on it in specific location to occupy the whole anatomical landmark including the crest of the ridge, denture border, median palatine suture, palate, and posterior palatal seal area (Figure 7), and used as guide for all denture bases for standardization the measurement [10].

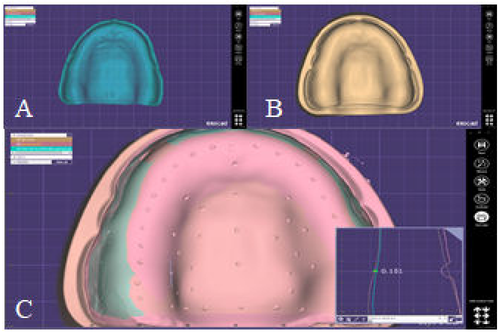

Figure 7: A) Virtual record base after processing; B) Represent the virtual cast and its record base. C) Show the three layers after superimposition (cast, base and the reference for 60-point standardization).

Mechanical and physical properties specimens

One design used for all the three groups (milled, 3-D printed and heat-cure acrylic resin), in which it designed by geometric designing program (AutoCAD) according to the selected dimension and saved as STL file [11].

For the conventional heat cure, a plastic pattern was constructed using highly accurate laser cutting machine from the STL file that designed previously by AutoCAD. During the mold preparation, the traditional water bath processing approach for full dentures was used. While the CAD-CAM and 3-D printer specimens were followed the same protocol for the denture base fabrication except that the design was taken from (AutoCAD) as STL file [12].

Statistical analysis

Statistical analysis software is used to carry out the analyses (IBM SPSS Statistics 26). The ANOVA test was utilized to examine the obtained mean values. When (p value) was less than 0.05, statistical significance was reported for all comparisons [13].

RESULTS

The null hypothesis was rejected as a result of the findings of this study, that state that no differences among the three-processing technique (conventional, CAD-CAM and 3-D printer) in mechanical properties and confirmed that variation among the processing technique occurred. Of the three-technique evaluated, the CAD-CAM is the best method of acrylic resin production throws the mechanical properties followed by conventional acrylic resin while the 3-D printer is the least mechanical properties. Descriptive statistic including mean, standard deviation and slandered error are illustrated in Table 1 [14].

Table 1: Comparative analysed of the mean values among denture base adaptation, hardness and roughness.

Variables	Techniques			P value		
	Conventional	CAD-CAM	3-D printer	C-CAD	C-3D	CAD-3D
	Mean ± DS	Mean ± DS	Mean ± DS			
Denture base (mm)	0.21 ± 0.03	0.18 ± 0.01	0.03 ± 0.02	0.008	0	0
Hardness (N/mm)	85.85 ± 1.01	87.94 ± 1.15	78.22 ± 1.83	0.002	0	0
Roughness (µm)	1.26 ± 0.03	1.22 ± 0.03	1.71 ± 0.19	0.919	0	0

Regarding the denture base adaptation comparing the CAD-CAM with conventional and 3-D was statistically significant differences were found (p<0.01) when the conventional comparing with 3-D and CAD-CAM, a statistically significant difference was found (p<0.01). When the 3-D comparing with CAD-CAM and conventional, a statistically significant difference was found [15]. For the surface roughness test comparing the CAD-CAM, a statistically significant difference was found (p<0.01), when compared with 3-D, and non-statistically significant difference was fount (p>0.05), when compared with conventional, when the 3-D comparing with conventional, a statistically significant difference was found (p<0.01) when the conventional comparing with CAD-CAM, a non-significant difference was found (p>0.05) [16,17].

Evaluation for surface hardness comparing the CAD-CAM with conventional and 3-D was statistically significant differences were found (p<0.01), when the conventional comparing with 3-D and CAD-CAM, a statistically significant difference was found (p<0.01), when the 3-D comparing with CAD-CAM and conventional, a statistically significant difference was found (p<0.01) (Table 2).

Table 2: Tukey's multiple comparisons test comparing CAD-CAM, conventional and 3D-printer acrylic denture base adaption.

Group 1	Group 2	Mean differences between (1 and 2)	P value	Signature
CAD-CAM	3D-printer	-0.15344	0	S
	Conventional	-0.03551	0.008	S
3D-printer	CAD-CAM	0.153443	0	S
	Conventional	0.117936	0	S
Conventional	CAD-CAM	0.035507	0.008	S
	3D-printer	-0.11794	0	S

DISCUSSION

Complete Dentures (CDs) should offer a close fit with the mucosa to improve masticatory cycle performance. The goal of using new and improved technology to make CDs was to enable the optimal mucosal adaptation. Another significant aspect of CD production is the technique's repeatability, which ensures that the same precise denture foundation is produced every time. One of the limitations of conventionally constructed complete dentures is the net volumetric shrinkage of PMMA, which results in poor denture base adaptability as a result of dimensional changes [18]. The CAD-CAM denture blocks are made by machining an acrylic resin cylinder that has been performed. This cylinder is made under high pressure and heat, preventing the definitive milled prosthesis from shrinking. When compared to a conventionally treated denture, the highly condensed resin causes a reduction in free monomer and porosity, resulting in a reduction in surface roughness. The findings show that the newest processing technique, CAD-CAM provides a desirable balance of minimal fabrication distortion and consistently better adaptation, with the smallest gap values followed by conventional and the largest gap in 3-D printer denture base, where a significant difference was found between all three groups. This coincide with the result of in which, when compared to pack and press, pour, and injection denture base processing processes, the CAD-CAM manufacturing process was shown to be the most accurate and reproducible denture production methodology. However, it contrasts with the finding of They found that CAD-CAM and injection moulded CRDPs have a much lower overall intaglio surface trueness than traditional CRDPs.

Furthermore, the best-fitting alignment modality allows for complete seating of the superimposed digital surfaces, with negative and positive values denoting surface deviations. The digital superimposing enables to measure the areas where the denture base implies a compression to tissue is shown by negative values. However, those areas would probably prevent the denture base from seating as accurately as this modality allowed, leading to a greater misfit. As a result, rather than the actual denture base adaption, the digital superimposition method should be viewed as an assessment of overall trueness. Also, previous studies performed by either physical or digital techniques generally evaluated the gap using linear measurement of the vertical distance between the cast and base. However, because the gap between denture base and dental cast was in 3-D space, linear measurements alone would be insufficient to assess it [19].

CONCLUSION

When compared to heat-cure and 3-D printer denture base processing processes, the CAD-CAM fabrication process was shown to be the most precise and reproducible denture production methodology. At the mid palatine suture, posterior palatal seal, and palate, CAD-CAM produced the most precise adaptation. The conventional approach was most accurate at the crest of the ridge and the denture border, according to the median results. CAD/CAM PMMA showed decreased surface roughness values than conventional PMMA and 3-D printed PMMA.

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