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Evaluation Of Retention and Assessment of Biting Force Distribution of a Complete Denture Fabricated Using 3D Printed Custom Trays with Arcus Digma Versus Conventional Method (A Cross Over Study)

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Aim: The purpose of this study is to evaluate retention and occlusion of complete dentures fabricated using 3D printed custom trays with the aid of arcus digma in less steps versus conventional method.
Materials and methods: Ten patients were selected to participate in this study. For each one, two complete dentures were constructed, Group I were rehabilitated with a conventional complete denture, while Group II were rehabilitated with a complete denture constructed using 3D designed and printed custom trays with gothic arch tracing of jaw relation with the help of arcus digma.
Results: By comparing the two groups there was a significant difference between them in biting force distribution where (SD) values for biting force difference posteriorly between the right and left posterior segments for centric occlusion was significantly higher for Group I (20.52±7.99) than Group II (14.45±7.33). Anteriorly Group I (27.85±25.68) had significantly higher mean value for biting force distribution than Group II (21.70±23.92). While there was no significant difference between them in retention evaluation where Group II (31.36±2.73) showed higher mean value than Group I (28.95±5.95), yet the difference was not significant.
Conclusion: Within the limitations of this study, it was found that dentures made by using gothic arch technique in taking centric relation by the help of arcus digma was more accurate in occlusion, this means that the force was more evenly distributed on the denture leading to better stability and fewer adjustments. Dentures made using this technique also had retention competent to regular dentures.

Keywords: Arcus digma ; Gothic Arch ; Printed Custom Tray

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Introduction

Complete denture methods of fabrication have remained unchanged relatively since 1936. The conventional protocol for fabrication of complete dentures necessitates a series of various laboratory and clinical steps including primary impressions, manufacture of a customized special tray, definitive final impressions making, occlusion rims construction, generating jaw relationship records, trial setting-up of the prosthetic teeth, try-in stage, flasking the denture, the packing of acrylic resin, processing and prosthesis delivery and insertion.[1]

On average, the process of complete denture construction and fabrication involves five appointments at least, assuming that the patient will accept the overall esthetics when we reach the try-in appointment just before the CD prosthesis is processed and delivered.[2]

Several manufacturers have already established a protocol for clinical and laboratory steps which enables in fewer steps the finalization of the CD. These recent clinical protocols consist of a sequence of conventional with intervening digital steps for the manufacturing of complete dentures. The first patient appointment routinely comprises making of impressions, as well as registration of maxilla-mandibular relationship (MMR), the establishment of the proper orientation of occlusal plane then subsequently delivering the dentures to the patient at the final appointment.[3]

Inokoshi et al.[4], described one of the simplified denture construction techniques for patients with old complete dentures. He evaluated time taken to fabricate complete dentures fabricated using RP and traditional methods. RP methods saved a lot of time, but the overall esthetics and stability as rated by the prosthodontist was in favor of the conventional method.

Schwiger et al.[5], concluded that innovative treatment concepts for the fabrication of complete denture, which include digital components, may significantly increase the predictability of the treatment outcome. Digital technology has helped reduce the number of appointments, improved material biocompatibility, given us the possibility of virtual patient evaluation through impression scans, rim scans with face scans and reduced the cost which led to a considerable change in the treatment workflow. These benefits have become more crucial taking into consideration the increase in the aging population.

In recent years, significant advances in the dental field have occurred due to the development of computer-aided design, and computer-aided manufacturing (CAD-CAM). Design, manufacture and analysis of products by the aid of computer skills is referred to as Computer-aided technology. It can either be in the form of additive manufacturing (referred to as rapid prototyping) or subtractive manufacturing (referred to as computerized numerical control [CNC] machining). In Additive manufacturing, which represents 3-dimensional (3D) printing, sequences of images from a digital file are used in the formation of an object. Successive layering of certain materials produces an object. As for Subtractive manufacturing, it utilizes the images derived from a digital file to aid in the creation of an object by physically removing and cutting material out of a block by machining (cutting/milling) in order to achieve the desired physical geometry.[1]

Computer aided design and manufacturing and advances in rapid prototyping techniques have aided the digital workflow for the construction of complete dentures. They have significantly simplified the treatment, saved time and reduced the cost.[6-9]

The recording of the Centric relation (CR) is truly a crucial step in the process of manufacturing complete dentures. The most widely used methods are the Gothic arch which represents the functional tracing and the use of Wax occlusion rims which represents the static method for recording the CR in complete dentures.[10-11] Although the use of occlusion rims is more widely used as it is less technique sensitive Gothic arch tracing is known to be more accurate.[10,12]

Despite its accuracy reports focused on the fabrication of complete dentures using the gothic arch in a digital workflow are rare. Traditional gothic arch tracing cannot be properly observed during the tracing procedure of the mandibular movement consequently this method loses some of its value and consumes a lot of time and effort. In addition, we cannot correct or prevent any shift of the stylus position from the correct position at the apex of the tracing while the material is being injected because any shift that happens is not observed directly, the procedure must be repeated.[13]

To overcome such limitations, and in line with the digital dentistry era the system of ARCUS digma that is able to record and analyze the movement of the mandible in a three dimensional manner with the aid of ultrasonic electronic sensor that enables us to accurately measure the patients condylar guidance that appears on a computer screen, was ultimately developed.[13]

The arcus digma shows Real time replication of the mandibular motion through a monitor; moreover, condylar and anterior guidance are accurately identified. In addition, it is possible to evaluate the reproducibility of centric relation along with the ability to reproduce this mandibular motion on an articulator.[13]

Recent gadgets like the digital force-meter have made it feasible to measure denture retention by measuring the resistance of the denture to vertical displacement. This device applies a pulling force on an attached metal hook located in each maxillary denture's geometrical center.[14]

For many years, the most common diagnostic tool used in the identification of the occurring contact points of the maxillary and mandibular teeth has been articulating paper. Although it is able to highlight occlusal contacts, it cannot quantify their intensity accurately or measure the magnitude of the occlusal forces generated. It cannot also give an indication on the exact timing of occlusal contact.[15-17] In this study, Occlusal analysis was done using T-Scan III this allowed the occlusal contacts to be recorded conveniently and easily. The device has a great potential and can aid in clinical diagnosis as well as treatment of occlusion because it provides precise recordings of the force as well as timing of tooth contact which are utilized as valuable diagnostic variables. T-Scan does not only enable the accurate occlusal contact recording, but in addition it helps analyze their force level as well as timing with high precision (100%).[18] The T-Scan III computerized system can determine prematurity, high points, non-uniform force concentration and regions of excessive force rapidly. In addition, It can accurately analyze disocclusion time.[18] This system avoids subjectivity in the articulating paper markings interpretation.

The objective of this study is to evaluate retention and occlusion of complete dentures fabricated using 3D printed custom trays with the aid of ARCUS digma in fewer steps versus conventional method of constructing complete dentures.

Materials and methods

Patient selection and grouping

Fourteen patients were selected to participate in this study from the out-patient clinic of the Prosthodontic Department, Faculty of Dentistry, Ain Shams University.

The selected patients were free from any Anatomical variations like TMJ disorders and systemic disease affecting neuromuscular control e.g., Parkinsonism, epilepsy, Bell's palsy etc. Only patients with adequate inter-occlusal distance and normal jaw relationship (class I) were included in this study. Patients with four widely distributed overdenture abutments in the mandibular arch which were successfully treated endodontically, had sufficient alveolar bone support, good periodontal health and no mobility on clinical examination were chosen to prevent denture base movement over rebound tissues to avoid the effect of resiliency of mucosa which could significantly have an effect on the stability of the denture base and as a consequence lead to false recordings during the process of gothic arch tracing.

All participants included in this study were provided with detailed information about the study where they were informed that they will be a part of a study that needs their best co-operation. They all agreed to participate and follow the instructions given to them in the form of a signed consent. All required steps were taken in order to ensure the protection of the security of the patient's personal information and the patient's health privacy information were taken. All participants were clearly given notice concerning all their rights, legal duties and privacy practices.

For each one of the patients two complete dentures were constructed, group I received a Complete denture by conventional method, while group II received a Complete denture using 3D printed custom trays for secondary impressions with jaw relation taken using arcus digma gothic arch technique.

All prosthetic steps were done by the same prosthodontist to confirm uniformity of all steps.

Designing and printing of trays as well as tracing of jaw relation with the help of arcus digma was done in the digital center, faculty of dentistry, Ain Shams university. Each patient received two complete dentures at the end of the study.

Prosthetic steps

Upper and lower alginate impressions were made for the selected patients and then dental stone was poured to get diagnostic casts. A tentative centric jaw relation record was made, and then mounting of the casts was accomplished on a simple hinge articulator in order to evaluate their inter-arch distance and inter-ridge relationship.

Abutment teeth were reduced in height to about 1-2 mm above the attached gingiva and contoured to a dome shaped preparation with 15 degrees angulation mesially, distally and lingually and 30 degrees buccally. All line angles were rounded and smoothed. The crest of the dome shape was prepared over the long axis of the tooth. Stannous fluoride gel was applied to the prepared surface. Removal of 2ml of gutta percha from the root canals by gates size 2 was done and after cleaning them from any debris self-etch bond was added then the cavity was filled by flowable composite then cured with light cure.

A) Conventional method

For group I maxillary and mandibular primary impressions were obtained in correctly selected and properly modified stock trays with the use of compound cakes impression material (Pyrax compound cakes, in Roorkee, Uttarakhand (India))and afterwards they were poured in with dental stone to get upper and lower diagnostic casts. Self-cure acrylic resin special custom trays were constructed over the obtained diagnostic casts. The depth of the vestibule was marked and the tray borders were then trimmed about 2-3 mm shorter. Adhesive material was subsequently applied to the tray, then border tracing and the final wash was performed with the use of medium consistency polyether impression material (Elite Soft Medium Body – zhermack). maxillary and mandibular secondary impressions were then poured in with dental stone to get upper and lower master casts. Upper and lower occlusion blocks were fabricated on the master casts. Face bow record was taken to help mount the maxillary cast on a semi adjustable articulator (Semi adjustable articulator Kavo protar). The lower cast was mounted by centric occluding relation recorded following the interocclusal wax wafer technique.

Protrusive record was made with other occlusion blocks to adjust the articulator horizontal condylar guidance. Right and left lateral records were taken using the check bite method with another two occlusion blocks for each. Records were transferred to a semi adjustable articulator. Setting was done to provide bilateral balanced occlusion.

A trial complete denture was fabricated, proper seating of the denture was confirmed during the try in stage then delivered to the patient after making the needed adjustments.

The upper and lower waxed up dentures were flasked, wax elimination was done, application of separating medium was performed, packing of heat cured acrylic resin was accomplished, then the flask was closed, and curing was done using long curing cycle. After deflasking, laboratory remount was carried out before finishing and polishing the dentures.

The patients were instructed to perform oral and denture hygiene. The patients were instructed to take the denture out of the mouth for at least 8 hours every 24 hours during sleep and placed in a container containing tap water. The patients were instructed also to brush the prosthesis and abutment teeth after each meal.

B) Digitally augmented steps:

For group II Upper and lower primary impressions (Fig.1) were taken by using intra oral 3D scanner (CEREC Omnicam) digital impression technique directly from the patient mouth to scan the upper and lower arch because it significantly decreases the required time needed for laboratory and clinical work, and the effort and material needed to make plaster casts. It significantly reduces patient discomfort on comparison with traditional physical impression technique. It eliminates the need for impression materials and trays, that are usually very uncomfortable for the patient, in addition patients with strong gag reflex will comfortably use it. In fact, as reported by literature, most patients favor optical impressions to conventional impressions.

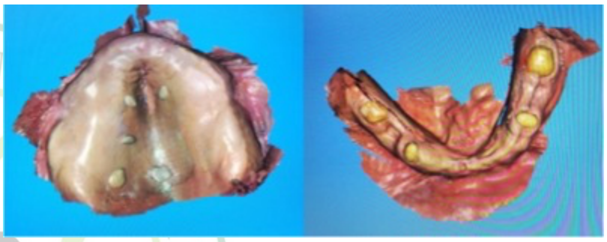

Fig. (1): Intra oral scanning of upper and lower arch

In addition, by using this technique we can obtain more accurate custom trays to fabricate definitive impression precisely. So, a technique was developed to merge the intraoral scanning and the printing to make a custom tray and omit the need for primary impression.

All intraoral cameras record individual images or videos by light projection. They are then compiled using the software after the POI (points of interest) are recognized. Evaluation of the first two coordinates (x and y) of each point on the image is done and depending on the distance to the object the calculation of the third coordinate (z) is performed according to the technologies related to each camera. The time needed for a full arch scan was 15 min.

The lips were retracted with a cheek holder and saliva was constantly removed with an aspirator during intraoral scanning by “zig-zag” scanning technique with the help of round parts of composite (3M-ESPE) widely distributed in a fixed positions with occlusion sprays (Occlutec) that act as a reference help the scanner to catch the image and make the surface dry to avoid glossy surface, so it overcome the limitation of scanner during scanning..

Silicone putty impression material was polymerized while maintaining the vertical dimension between the upper and lower jaws. The polymerized silicone putty was used as a jig after being cut to a relative thickness of around 15 mm.

The silicon jig was positioned between the jaws and it was scanned along with the maxillary and mandibular arch. The standard tessellation language data of the maxillary and mandibular jaws and jig was imported to obtain a jaw relation record to aid in the editing and trimming of the data of the primary impression. Exocad 2.2 valleta software was used to help design as well as create the supporting system for the construction of the custom trays (CAD/CAM trays) utilizing a rapid prototyping system, Additive layering technique, where 3D printing custom tray were printed by the use of a special resin material (EPAX 3D printed resin) (Fig.2).

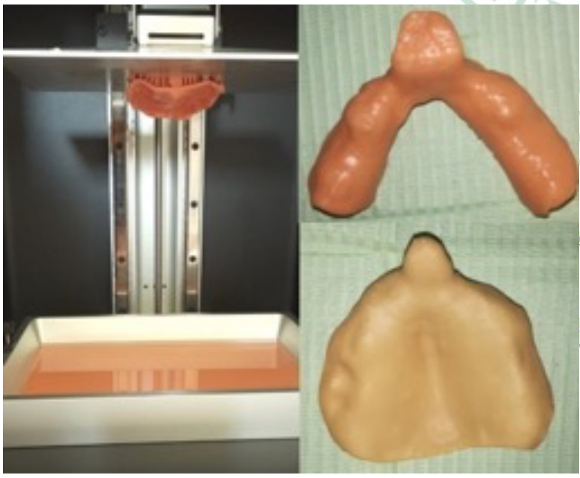

Fig. (2): Upper and Lower printed custom trays by additive layering technique

CAD/CAM trays were used to make the definitive secondary impressions for the maxillary and mandibular jaws. Adhesive material (Zhermack universal tray adhesive) (Fig.3) was applied to the tray, then border tracing and the final impression wash were done using medium consistency polyether impression material (Elite Soft Medium Body – Zhermack).

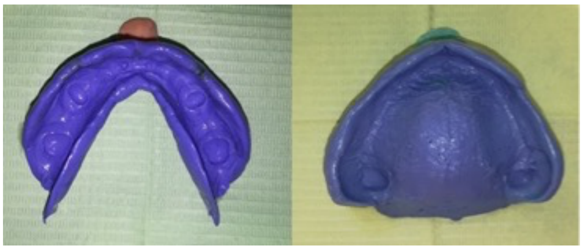

Fig. (3): Upper and Lower secondary impression with printed custom trays.

On the same visit the handle of the custom trays was removed and the occlusion rim was made on the maxillary and mandibular custom tray with wax. The occlusal plane orientation, as well as the lip fullness and appearance were determined by evaluating the occlusion blocks.

The mandibular Gothic arch guiding plate and the tracing screw were assembled (fig.4). The entire appliance was put into the patient's mouth and the tracing screw height was adjusted according to the vertical dimension that was previously recorded, then the lower wax rim was reduced to provide a space for the injection of bite registration material.

Fig. (4): Pin in upper, Plate in lower the height of the tracing screw was adjusted to the previously recorded vertical dimension for recording centric relation using gothic arch tracing.

The patient was educated about the device and the required instructions that were needed to be followed. The components of arcus digma were placed in the patient. The upper face bow was secured to the upper arch. The lower facebow was secured to the lower arch using the Para occlusal clutch prepared earlier (fig.5). Facebow orientation was adjusted as described earlier with patient setting upright (90 degrees). Diagnostic module was used, the facebow record was first taken while the patient stays still using the arcus digma to determine the spatial orientation of the maxilla on the software. Recording the centric relation was done by using Gothic arch (most accurate). The patient was asked to slowly perform lateral and anteroposterior mandibular movements while the maxillary and mandibular custom trays were in contact. Then the patient was asked to repeat the previous movements to obtain the mandibular movement tracings showed on the screen.

Fig. (5): Placement of the arcus components in the patient face.

The patient was then asked to move his mandible to reach the exact position at the point mark of the movement trails where the metal tracing screw was previously located to make sure that the mandibular tracings were clear. The occlusal registration material (CharmFlex® Bite) was injected between the upper and lower custom trays. After the two custom trays were properly fixed, it was removed and was sent to the laboratory. Upper and lower secondary impressions were then poured using dental stone to get upper and lower master casts. Mounting of upper cast was done using maxillary (KTS) biting fork that was taken from the patient placed on digma mounting table that was placed on the articulator.

The multiple advances offered by the KaVo Transfer System (KTS) include the axial system, along with the special transfer status which easily permits the quick and smooth transfer of the models to the KaVo PROTAR articulator. This method prevents a lot of the possible transmission errors. The axis does not need to be determined because the articulator axis of the PROTAR is used as the axis system. For the setting of the calculations of the articulator, the bite fork stands in a known relationship with the articulator joints whose settings were calculated.[13]

Subsequently the centric relation record that was taken using bite registration material was placed on the upper occlusion block, then the lower master cast was attached and mounted into the lower member of the articulator. Transfer angles were taken to adjust and register values of the right and left condylar path inclination (protrusive record), and left and right Bennett angle (right and left laterotrusive records), on the joint mechanism of the dental articulator. Setting was done to provide bilateral balanced occlusion. Try in, delivery and lab remount with denture construction same as in group I.

Retention evaluation

In order to evaluate the maxillary denture retention, the geometrical center of the maxillary arch was located and chosen as the measurement point. The exact center of the maxillary denture was marked on the definitive cast by locating the exact center of the incisive papilla and the hamular notches. Then, the distance halfway between points b and c was measured and the point was marked on the denture base posterior border (point D). Finally, half the distance between point a and d was marked as the center of the denture (point E). Self-cured acrylic resin was used to

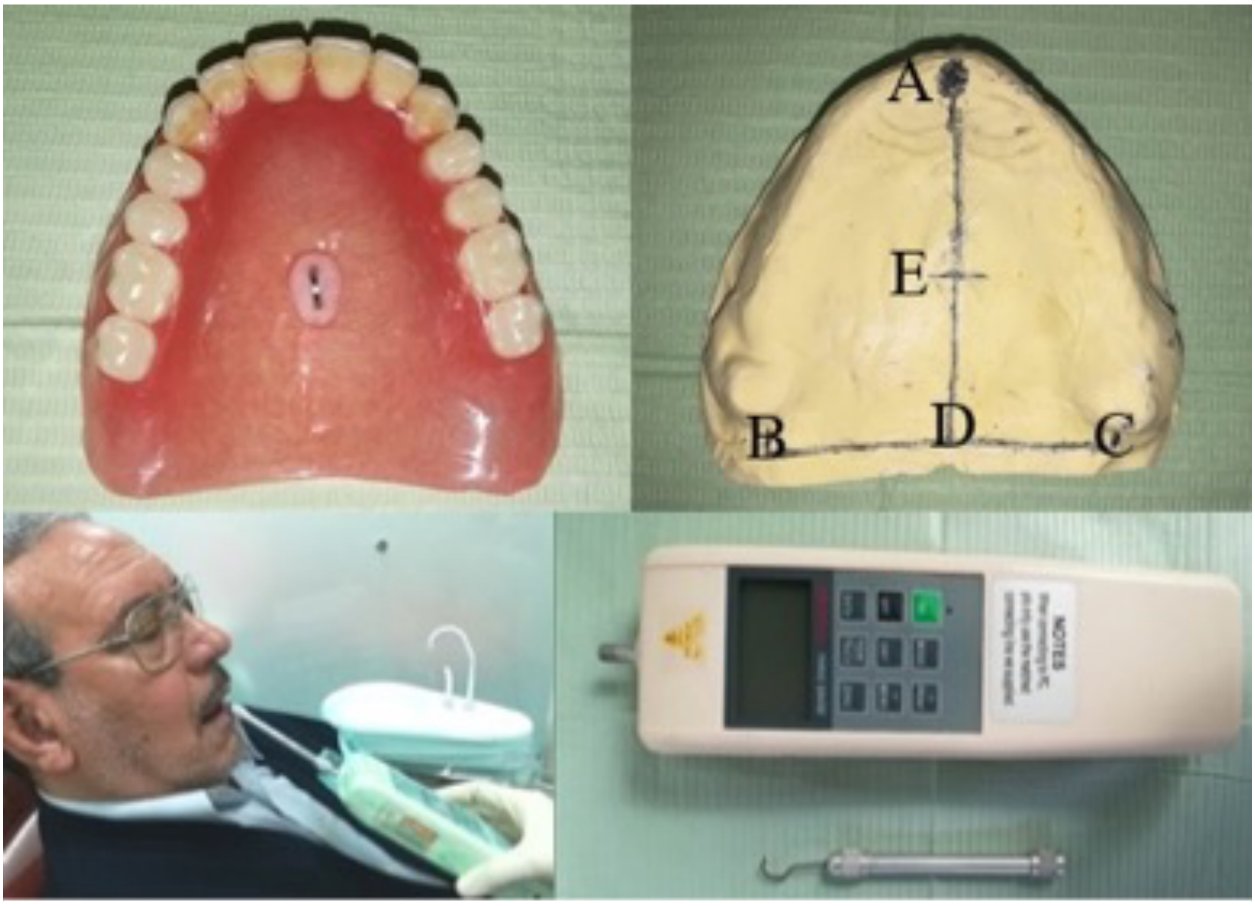

Fig. (6): Location of the geometrical center of the arch, stainless steel hook attached to the upper denture, Digital force gauge HF-100

attach a stainless-steel hook at the predetermined position of the geometric center, to the outer surface of the denture. The retention of the denture was recorded by the use of a digital force gauge (Digital Push Pull Gauge Force Gauge HF-100N) (Fig.6).

The device was prepared, then, the unit of measurement was chosen in Newtons and the peak hold option was selected. The desired adapter tension hook was attached to the sensing head. Before each measurement the display was calibrated to zero using the zero button. The denture was inserted in the patient's mouth and allowed to remain for settling time of 10 minutes before the stainless-steel hook was engaged. The patient was seated in the dental chair in an upright position with his lips relaxed and his mouth opened. In this position the palate and the maxillary ridge were set to a position nearly parallel to the floor. Therefore, the dislodging force that was applied was set to be almost perpendicular to the denture.

This dislodging force was repeatedly applied to the denture base hook until it was ultimately forced out of its position. Retention force was considered as the maximum force needed to completely dislodge the denture. This measuring procedure was consequently repeated five times at an interval of ten minutes for each denture base then recording of the average value was performed. Retention measurements were done at the same time of the day for all the patients.

Occlusal analysis of bite force distribution using T-Scan

The key component is the sensor. On biting on the sensor, the resultant change in electric resistance is directly converted into an image on the screen. The program can be operated on two modes force analysis and time analysis.

The width of the maxillary central incisor of each subject was measured by a periodontal probe. The sensor was placed in the patient's mouth, with the sensor support pointer between the two central incisors and the handle was kept as parallel to the occlusal plane as possible. The patient was asked to close, and the tooth contact was observed on the screen. The patient was instructed to bite down normally on the sensor for 2 seconds and then opened slowly.

When recording was completed, the Realtime window turns into a 2-D Movie window, that was divided into two equal-colored boxes (one green for the left side and one red for the right side) around the mid-sagittal plane showing the difference between the intensity of the biting forces on both sides. A 3-D Movie window, Graph window and Graph Zoom window were also automatically opened for the current movie. The Graph and Graph Zoom windows contain color-coded "traces" representing the forces applied on each tooth, the magnitude of forces applied, the distribution of the forces along the arch and teeth under heavy contact and premature contact inside each of the colored boxes in the 2-D Movie window. The same process was done to estimate contact at protrusive and lateral eccentric. Each movement was repeated thrice and the average of three recordings were taken.

The results were collected, tabulated, and statistically analyzed to compare between the two groups.

Numerical data were presented as mean and standard deviation values and were analyzed for normality using Shapiro-Wilk test. Biting force data showed non-parametric distribution, so they were analyzed using Mann-Whitney U test, while retention data showed parametric distribution, so they were analyzed using independent t-test. The significance level was set at $p \leq 0.05$ within all tests. Statistical analysis was performed with R statistical analysis software version 4.1.2 for Windows.

Results

The digital force gauge was used to assess retention of the maxillary denture that revealed after statistical analysis that Gothic arch group showed higher mean value than conventional group but there was no significant difference between the two groups in retention evaluation (Table 1).

Table (1): Mean and Standard deviation (SD) values for retention in different groups

Retention (Mean±SD)		p-value
Conventional	Gothic arch	
28.95±5.95	31.36±2.73	**0.178ns**

*; significant ($p \leq 0.05$) ns; non-significant ($p>0.05$)

T scan was used to assess occlusion of both dentures. On comparing the occlusal force ratio for right and left, between group I and group II, which are described as (100 percent represented by 1.0). The test revealed after statistical analysis that there was a significant difference between the two groups in occlusal analysis where mean and Standard deviation (SD) values for biting force difference between the right and left posterior segments for centric occlusion in the conventional group showed significantly higher value than gothic arch group which indicates that the biting force was more equally distributed both side in the gothic arch group. This group required only a slight occlusal adjustment while conventional group need more occlusal adjustment. Anteriorly conventional group had significantly higher mean value than gothic arch group indicating more unfavorable contact anteriorly that needed more occlusal adjustment to achieve no contact anteriorly to avoid instability of the denture (Table 2).

Conventional group rendered a less favorable biting force distribution to reach for the optimum occlusion than gothic arch group and statistical analysis of the digital measurements confirmed these findings.

Table (2): Mean and Standard deviation (SD) values for biting force difference posteriorly for centric occlusion for different group and Mean and Standard deviation (SD) values for biting force distribution for centric occlusion in different groups

Biting force distribution difference posteriorly for centric occlusion (Mean±SD) (Mean±SD)		p-value
Conventional	Gothic arch	
20.52±2.99	14.45±2.33	0.002*

Side	Biting force distribution for centric occlusion (Mean±SD)		p-value
	Conventional	Gothic arch	
Anterior	27.85±2.68	21.70±3.92	0.039*
Posterior	72.12±5.75	78.25±3.93	0.044*

*; significant ($p \leq 0.05$) ns; non-significant ($p>0.05$)

Discussion

The benefits resulting from application of this procedure were multiple. The use of 3D printed custom trays helps in the matching of the anatomic structures more accurately for the fabrication of the definitive impression. So this technique was developed to merge the intraoral scanning and the printing to make a custom tray and omit the need for a conventional primary impression.[19]

The process of impression digitalization for CDs makes the communication of intraoral information directly to the technician after performing the scan much easier, the prosthodontist can e-mail the images to the dental laboratory, where its accuracy can be immediately checked by the technician. If for any reason the dental technician is not fully satisfied with the observed quality of the optical impression he received, the prosthodontist can feasibly perform another scan without the loss of any material or time and without the need to recall the patient to attend for a second appointment. This specific aspect truly strengthens and simplifies the communication process between the prosthodontist and the dental technician.[20-22]

The technique used in this study aims to simplify the assembly of the Gothic arch tracing method by the use of a digital face bow(ARCUS digma), resulting in a more convenient and applicable centric relation recording.

ARCUS digma system was chosen for its ability to accurately reproduce the inherent condylar guidance as well as the locational relationship between the maxilla and mandible in patients where results obtained for the final prosthesis were exceptionally satisfactory as evaluated by t scan. These superior results could be attributed to the fact that the lower jaw can move freely in relation to the upper jaw without performing any type of occlusal interaction. This excludes the influence of operator and occlusal interference on TMJ kinematics. It can obtain a 3D representation of the real surfaces at real time of its movement which consequently leads to better recording and reproduction of harmonious occlusal contacts in the final prosthesis.[23]

Since digital networking information is more accurate, quality controlled complete dentures can be delivered to the patients with more predictable results than the conventional technique. The digitalization of the process of the fabrication of CD permits simplification of the regular complicated treatment and tedious laboratory processes which is required for the conventional method.[19]

Hence, this study was conducted to assess the retention and the occlusion of both dentures constructed using 3D printed custom trays after scanning both jaws with intra oral scanner. It simplifies centric relation recording using gothic arch technique by the help of arcus digma after combining it with definitive impression in a single step.

The digital force gauge was used to assess retention of the denture that revealed after statistical analysis that Group II showed higher mean value than Group I but there was no significant difference between the two groups in retention evaluation but less effort, time, materials and revealed to be more satisfactory to the patient.

T scan was used to assess occlusion of both dentures as it has the advantage of not only being able to record occlusal contacts but also being able to analyze their timing and force distribution level with high precision (100%) that revealed after statistical analysis that there was a significant difference between the two groups in occlusal analysis where mean and Standard deviation (SD) values for biting force difference posteriorly for centric occlusion were Group I showed significantly higher value than Group II which indicate that biting force was distributed more equally on both sides in Group II leading to better stability and fewer adjustments needed. Anteriorly Group I showed significantly higher mean value than Group II that need more occlusal adjustment to achieve no contact anteriorly to avoid instability of the denture.

The digital measurements confirmed this finding and the validity and accuracy of ARCUS digma system was confirmed.

The process of centering the occlusal force in complete dentures leads to the favorable directing of forces to help eliminate side to side unbalanced prosthesis torquing. These desirable end-results on prosthesis insertion were validated by the utilizing of the accurate data acquisition along with the occlusal force display features incorporated in the T-Scan III computerized occlusal analysis system. The prosthodontist can readily observe the exact location and distribution of occlusal force as well as the specific occlusal adjustments needed to attain a properly centered, measurably balanced biting force distribution. This is attained by the help of a full closure force movie recording, the COF occlusal force summation analysis and the force versus time graph.[24]

This balanced force distribution significantly improves the basal tissue seat supporting the denture by insuring that, while the denture is being loaded during mastication, it is properly seated by the occlusal force summation falling equally onto the broadest and the most supportive available tissue.[24]

Therefore, analysis of the data indicates that some clinical or laboratory steps can be skipped, which saves clinical time and reduces costs without prejudicing the prosthesis. Dental schools should consider these findings when designing complete denture courses.

Conclusion

Within the limitations of this study, it was found that dentures made by using gothic arch technique in taking centric relation by the help of arcus digma was more accurate in occlusion, this means that the force was more evenly distributed on the denture leading to better stability and fewer adjustments. Dentures made using this technique also had retention competent to regular dentures.

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