EGYPTIAN DENTAL JOURNAL
www.eda-egypt.org
Vol. 71, 681:693, January, 2025
Print ISSN 0070-9484 • Online ISSN 2090-2360
Fixed Prosthodontics and Dental Materials
Submit Date : 22-11-2024 • Accept Date : 28-12-2024 • Available online: 10-01-2025 • DOI : 10.21608/edj.2024.336526.3261

COMPARATIVE STUDY OF THE RETENTION OF AN OT EQUATOR WITH SMART BOXES VERSUS NOVALOC ATTACHMENT FOR MANDIBULAR IMPLANT-ASSISTED OVERDENTURES (IN VITRO STUDY)

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ABSTRACT

Background: Due of their numerous benefits over traditional complete dentures, implant-supported mandibular overdentures are now the first alternative option for individuals with fully edentulous ridges. Superior retention, which removes the worry of separation during surgery, is one of the main benefits of implant-supported mandibular overdentures. The existence of other well-known attachment mechanisms, which might lead to less maintenance requirements and other advantageous features, is the cause of this greater retention. The novel attachment type Novaloc, which is based on mechanical retention from a poly-ether-ether-ketone (Peek) matrix on a cylindrical patrix, is one of the possibilities. It could be more wear-resistant than the nylon used in previous systems. In order to reduce roughness and improve the resistance of the connection components between the implant and overdenture, the abutments are additionally coated with an amorphous carbon surface that resembles diamonds. For very challenging implant rehabilitation instances, the Rheumatoid 83 bespoke attachment abutment design service is perfect. Patients with significant implant divergence may benefit from using the Smart Box device in conjunction with the OT Equator. An internal tilting mechanism in the Smart Box allows for passive placement of divergent implants up to 50 degrees.

Objectives: To evaluate the changes in retention of OT Equator with Smart Box and Novaloc attachments. Two implants retained mandibular overdentures at initial, 3 months and 6 months after the insertion removal cycles.

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Materials & Method: In order to achieve inter-implant divergence 300, an in vitro investigation was conducted on a mandibular cast that was entirely edentulous and had two mandibular implants in the cuspid area bilaterally with 150 distal inclinations to the vertical axis. The castings were split into two equal groups: Group B received a Novaloc attachment, while Group A received an OT Equator with Smart Box attachment. 540 cyclic loads were applied to 16 overdentures. The attachments' retention was measured at baseline and after 270 and 540 cycles, or six months of simulation, respectively. A cyclic loading simulator and universal testing equipment were used to conduct the retention evaluation.

Results: The study revealed a significant decrease in the mean retention force in group I (Ot Equator with Smart Box) at baseline, after 270 cycles (3 months), and after 540 cycles (6 months). The OT-Equator with Smart Box group with medium retentive caps had equal initial and ultimate retentive probability values ($P<0.001$). This finding suggested that the retention force decreased significantly throughout all follow-up periods. Group II (Novaloc) with medium retentive caps showed a disparity in initial and ultimate retentive probability values ($P>0.126$) after 270 cycles and ($P<0.002$) after 540 cycles, indicating a significant decrease in retention forces after 270 cycles and 540 cycles, respectively. Regarding the retention forces of group I and group II at baseline and during various cycles, the study revealed significant differences in the mean retention force at baseline; however, these differences were not significant after 270 cycles and were significant after 540 cycles. The initial and ultimate retentive probability values were $P<0.001$ at baseline, $p>0.080$ after 270 cycles, and $p<0.046$ after 540 cycles.

Conclusions: The OT-Equator with a Smart Box Attachment group had better initial retentive force than the Novaloc attachment group with a medium retentive cap. The Novaloc attachment group had a more advantageous final retentive force. Mandibular overdentures supported by implants with Novaloc attachments are a reliable and effective therapeutic option.

KEYWORDS: Nonparallel implants, Equator (smart box) attachment, Novaloc attachment, Overdenture.

INTRODUCTION

One important oral disease issue that was evaluated was residual ridge resorption, which is characterized by the loss of jawbone following tooth extraction. All patients have a decrease in alveolar ridge height because edentulous alveolar ridge resorption is a lifelong process. The form, size, and tolerance of the remaining ridges give a complete denture stability, retention, and support [1, 2].

The loss of mandibular bone was estimated to be four times greater than that of maxillary bone. Because the entire lower denture supporting surface was smaller, less substantial, and had a less acceptable basal seat shape, differences in resorption were explained. Consequently, because the lower ridge is expected to tolerate greater stresses during function transmitted by the denture, the pressure on it is substantially greater than that on the maxillary ridge [1-4].

The preservation of the jawbone is one of the benefits of implant-supported prosthesis, which is regarded as a reliable technique in the rehabilitation of full edentulism and is recognized globally for its effectiveness in terms of function, nutrition, and overall quality of life. The rate of bone loss caused by traditional dentures is decreased with dental implants, which fuse with the jawbone. In fact, an early implant can even slow down the inevitable remaining ridge resorption [5-7].

The most basic repair for the edentulous mandible nowadays should be an overdenture that is maintained by two implants that are positioned in the anterior jaw. Implants and attachments can be used together to improve the stability and retention of overdentures in individuals who are entirely edentulous. Implant overdenture attachments confirmed a significant improvement in mastication, phonation, denture stability and denture retention and improves the patient quality of life with positive results on general health of the edentulous patient[8].

The connection between the implant and overdenture is what gives implant-supported overdentures their greater retention over traditional full dentures. These attachments are primarily classified as either bar or solo, and based on the amount of movement permitted, they can also be classified as rigid or resilient. Implant quantity, distribution, and alignment, bone quality, arch form, retention requirements, and denture design all influence the attachment choice [9].

To join the implants with the overdentures, a variety of attachment methods were used; these attachments were divided into splinted and unsplinted types [10].

Over the years, a number of stud attachment methods have been created, such as OT Equator (Rhein83, Italy). The OT Equator attachment is made up of a titanium male abutment that has been hardened with titanium nitrite and has a semispherical shape that resembles ball attachments. It supports a stainless-steel retentive cap housing with nylon retentive inserts that come in four different retention levels that are color-coded. With its creative design, the OT Equator Smart Box is a container of caps that enables the attachment to be passively inserted even in divergence situations up to 500. There are four different kinds of retention caps: regular, hard, soft, and extra-soft [11-13].

The quantity, placement, and distribution of implants as well as the abutment selection are critical elements in the effective treatment of implant-retained overdentures. Implants should be perpendicular to the occlusal plane and parallel to one another for best results. Among the challenging anatomical characteristics that certain patients commonly come with include inadequate bone volume in all dimensions, the inferior alveolar nerve positioned anteriorly or superiorly, and/or crucial architecture that precludes the best possible placement of dental implants. These characteristics might include sharp, uneven ridges as well as rounded or straight ones [14, 15].

There may be benefits such as reduced maintenance requirements when using alternatives to popular attachment systems. A novel attachment called Novaloc, which is based on mechanical retention from a poly-ether-ether-ketone (PEEK) matrix on a cylindrical Patrix, is one of such substitutes. It could be more wear-resistant than the nylon utilized in previous methods. Additionally, an amorphous diamond-like carbon surface coating is applied to the abutments to reduce roughness and improve the attachment components' resistance [16].

Due to its excellent properties, PEEK has become more common currently in dentistry [17]. PEEK is a thermoplastic polymer that is semicrystalline. It has been utilised extensively in medicine since its initial introduction in the 1980s and has demonstrated excellent physical qualities. Its excellent physical qualities, such as its high modulus of elasticity and strength, biocompatibility with surrounding tissue, and resistance to corrosion and wear, are what account for its extensive application [18].

Although using the Novaloc attachment was reported for correction of inclined implants for overdenture fabrication [19].

The null hypothesis is that there will be no significant differences between OT Equator with Smart Box and Novaloc attachment systems in inclined implant-retained overdentures regarding retention force.

MATERIALS AND METHODS

This was a comparative experimental study in which the retentive force of an OT Equator was compared with those of smart box and Novaloc attachment systems.

Study Design (Figure 1)

For the present study, 16 identical completely edentulous mandibular overdentures were retained in a completely edentulous epoxy cast using two implants in the inter-foraminal region with 15 degrees of distal inclination for each to create an inter-implant angle of 30 degrees.

The models were randomly divided into two equal groups:

Group (A): Dentures were retained at the implants with an OT equator attachment.

Group (B): Dentures were retained at the implants with Novaloc attachment.

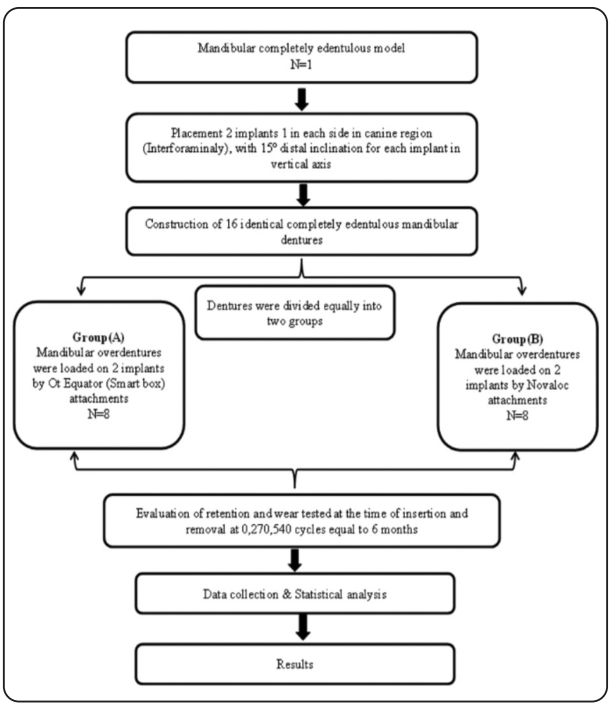


Fig. (1) Study design

Sample Size Estimation

The sample size was adjusted to a 95% confidence level to detect differences in retention force between the equator with the smart box and Novaloc attachments. Arnold et al. [20] reported a mean ± SD retention force of Novaloc attachment after thermocycling = 5.72 ± 0.63 N, while Rostom and Ragheb [21] reported a mean ± SD retention force = 10.61 ± 1.44 N in the case of an equator with a smart box. The calculated mean ± SD retention force difference = 4.89 ± 1.04 N, and the 95% confidence interval = 3.66, 6.57. The minimum sample size was calculated to be 7 per group, which was increased to 8 to compensate for laboratory processing errors. The total required sample size = number of groups × number per group = 2 × 8 = 16 [22].

MATERIALS AND METHOD

A) Fabrication of the mandibular replica [23]

A silicone-based cast-former was used to create a mandibular replica. The cast was placed on a vibrating table, and a type III dental stone was vacuum combined for 30 seconds. The cast was then removed, and a 2 mm thick hard acrylic thermoplastic clear sheet was applied using a vacuum former machine. The acrylic sheet served as a uniform spacer between the cast former and the manufactured cast. A thin layer of tin foil was painted to prevent resin adhesion. A specific type of epoxy resin was prepared and quickly poured into the former to avoid air bubbles. The epoxy cast was removed and split apart from the sheet when it had dried and hardened. The space between the cast and the cast former was filled with a layer of material that closely resembled mucosal tissues.

B) Mucosal tissues mimicking the edentulous mandible. [24]

The cast copy of an edentulous mandible was coated with a soft silicone lining substance to mimic resilient mucosal tissue. V-shaped grooves were cut into the sides of the replica to allow extra silicone material to flow and escape. The surface of the mandibular replica was roughened to improve adhesion of the gingival mask material. Petroleum jelly was applied to the former to separate it from the gingival material. A-silicon adhesive was sparingly painted on the cast replica before allowing it to cure. A thick glass slab was covered with the base and activator of the gingival mask material, which was uniformly mixed. The replica was placed inside the cast former, leveled with the surface, and pressure was maintained to avoid material rebound. After the silicon material hardened, the replica was removed and inspected for flaws and configuration. The mimicked mucosa was 2.5 to 3 mm thick. The varnish base and activator were applied uniformly to give the replica a shiny appearance and withstand scratches during subsequent treatments. (Figure 2)

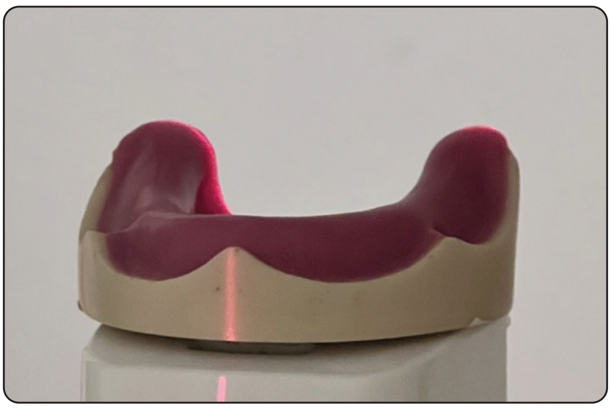


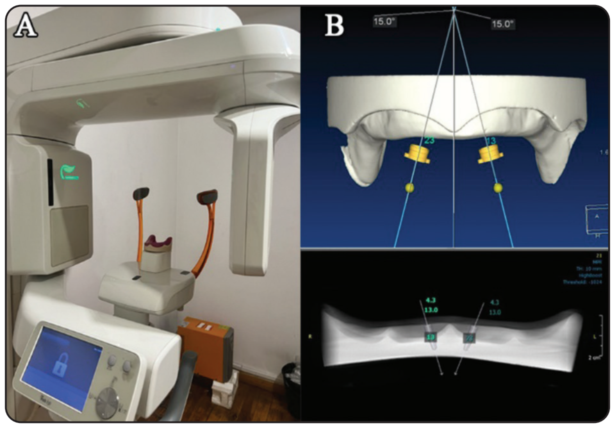
Fig. (2) The Epoxy Resin Cast (Replica).

Digital workflow

Fabrication of surgical guide

The surgical guide was created using specialized software and a 3D printer from a scanned epoxy model obtained from cone beam computed tomography (CBCT) (Figure 3A). The guide was made from the special resin dental material SG-100 to maintain the proper implant position.

For the purpose of preparing surgical guides, the epoxy model's DICOM and STL data were loaded into Blue Sky preparing Software. The STL file was placed on top of the DICOM file, and a virtual overdenture was used to layout implants in prosthetically driven placements. The implants were positioned bilaterally, 22 mm apart, between the canines and premolars. They measured 4.3 mm in diameter and 13 mm in length. Virtual planning was used to set a 15-degree distal inclination path for each implant, resulting in a 30-degree inter-implant angle (Figure 3B); subsequently, a guide was generated. (Figure 4A)



Fi.e (3) (A)Scanned epoxy model obtained by cone beam computed tomography (CBCT) (Green Veatch). (B) Virtual Planning of Implants to be 15 Degree Distal Inclination for Each Implant

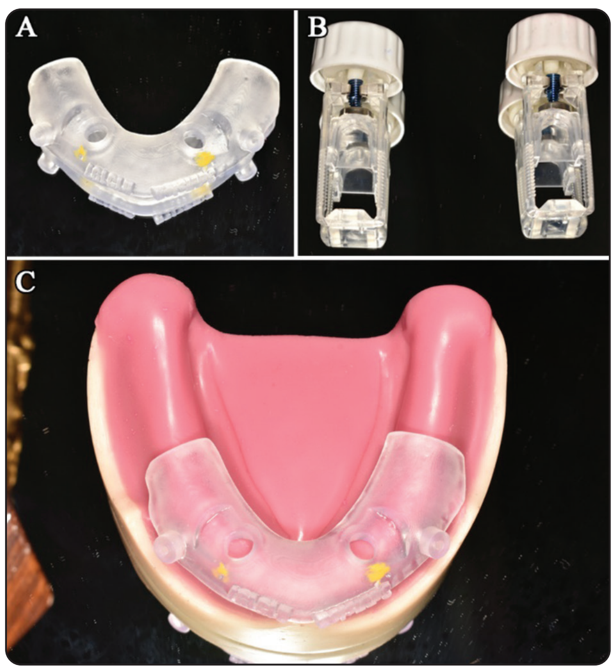


Fig. (4) (A) 3D Printed Surgical Guide. (B) Dummy Implants (Neodent, Straumann Group) (C) 3D Printed Surgical Guide Adapted to The Replica.

Implant placement

Two dummy implants (Figure 4B) were inserted into the model using a CAD/CAM surgical guide (Figure 4C). The implants were intended to be divergent 15× distally inclined, 13 mm long and 4.3 mm wide. The implants were inserted using a partially guided CAD-CAM surgical guide. After positioning the guide on the model, two bone anchor pins were used to ensure that it was stable and completely sealed (Figure 5). The sequential drilling procedure was followed using a guided surgical kit and a 24 mm drill length until the required implant width was achieved. The implants were then firmly attached to the model using a hand implant driver and torque wrench, achieving 50 Ncm primary stability.

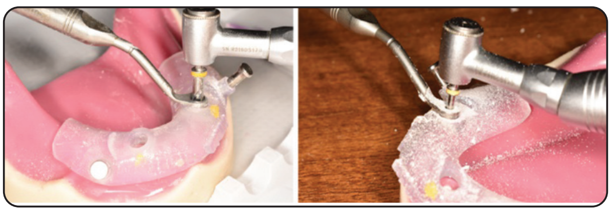


Fig. (5) Pilot drill & sequential guiding drills with 15° Angulation.

Mandibular overdenture fabrication [25]

Model data collection

The OT equator pair and matrix (Figure 6A) were scanned using a Medit T310 scanner as a 1st scan, and the Novaloc Patrix and matrix (Figure 6B) were scanned as a 2nd scan, capturing surface details on a colored dental napkin. The data were exported into an STL file and analyzed using Exocad software.

Epoxy resin denture conversion

A silicone impression was created by the attachment of the screwing implant to the implants. Then, the tissue was removed from the epoxy cast, boxed, and filled with vacuum-mixed Type III dental stone. Master casts were then poured, and surface hardener was applied to the cast surfaces for

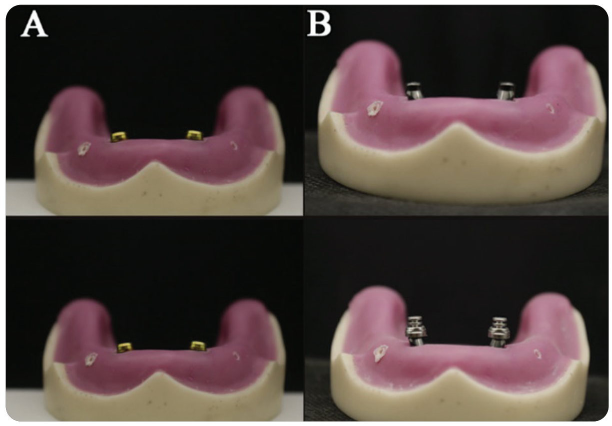


Fig. (6) (A) OT Equator Patrix and matrix. (B) Novaloc Patrix and matrix.

surface resistance and smooth separation. After the final setting, slight trimming was performed, and the steps were repeated 15 times according to the sample size.

Virtual denture design

Computer-aided software was used to create the mandibular overdenture, which included virtual gingival and anatomic pontic design modules for tooth positioning. The polished surface was described to resemble a natural gingival look, and denture base boundaries were drawn. The teeth, gingiva, and completed denture components were combined and saved in STL format. A 3D printer with specialized milling tools was used to output the CAD-CAM overdenture.

Digital denture replica

The overdenture was virtually designed in Excel software and fabricated using pre-polymerized resin acrylic pucks. A mock-up overdenture was created using vinyl polysiloxane impression material, and 15 additional last impressions were created. The test piece was filled with acrylic teeth, and melted baseplate wax was poured into it. The cast replica was set and re-evaluated with petroleum jelly and Vaseline applied to prevent stickiness. The cast was then set back into place and allowed to cool before the melted baseplate wax was poured into the putty index. The dimensions were re-evaluated and modified, and the putty index was removed. Melted wax was then used to seat the casts and their borders.

Processing of Overdenture Bases

Denture processing involves dragging type II dental stone through flasks, removing overdenture bases, and allowing them to set. Vaseline is applied to the investment, followed by a second mix. The flasks were placed in a boil-out tank to remove wax and rinsed, after which a layer of separating media was applied. Cold-cured polymerized denture base material (Vertex Castavaria) was prepared, packed, and polymerized at 74°C for 9 hours. The overdenture bases were retrieved, completed, and polished. The abutment hex driver is used to remove stud attachment matrices, and the intaglio is coated with pressure indicating paste and adjusted using a carbide bur.

Direct pickup of the abutments/housings

The sixteen complete edentulous mandibular dentures were divided into two groups based on abutment type: OT-equator with smart box abutment and Novaloc abutment. The attachments' matrices were backed up, and relief holes were cut into denture bases to accommodate the metal housing and matrix portion. Auto-polymerized acrylic resin monomer was applied to the gaps, and the resin was mixed and added to the relief spaces. After the fish were seated on the oral replica, the overdenture was set up, and the matrices were removed using the positioner core tool, which has a female removal tool. The clear and black processing replacement female was replaced with the final plastic positioner replacement female (medium retention), providing the appropriate degree of retention (1200 g), yellow in color for Novaloc, and orange in color for the OT Equator. The remaining 15 overdenture bases were used to complete the pickup stages.

Retention test

A universal testing equipment was used to apply tensile stress perpendicular to the occlusal plane after the dentures were linked to guarantee paralysis (Figure 7A). In order to replicate the rate of mechanical dislodging from the remaining alveolar ridge during mastication, the dislodging force was applied axially, and the crosshead speed was changed. For every system with retentive cap resilience, the maximum load to dislodgement was noted. A cyclic tension-compression test was conducted vertically, simulating 270 and 540 cycles, using specifically made cycle loading equipment (Figure 7B) that functioned as a dental mastication unit to mimic the insertion and removal of the 16 overdentures [10, 26].

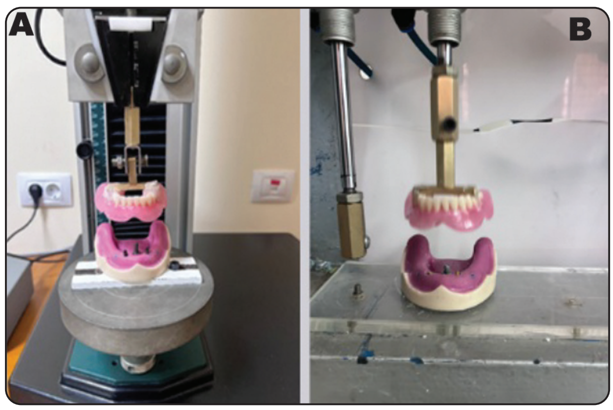


Fig. (7) (A) Dentures connected across UTM to measure peak load. (B) Cyclic loading simulator served as a dental mastication simulator.

Statistical analysis of the data [27]

The data were analyzed using the IBM ***SPSS software package version 24.0.***

Normally distributed quantitative data are presented as the mean and standard deviation.

An independent t test was used to compare two independent variables for normally distributed data, while the F test (ANOVA) was used to analyze more than two variants.

One-way analysis of variance (ANOVA) was performed for comparisons between more than two groups.

RESULTS

In this experiment, the retentive forces of OT-Equator with a smart box and Novaloc attachments on two implant-assisted mandibular overdentures were measured and compared.

The following are the data collection, tabulation, and statistical presentations:

Results of the retention force evaluation:

For both groups, the retention force of each attachment type was measured at different follow-up periods, at the baseline, after 270 cycles, and after 540 cycles.

Group I (Ot Equator with Smart Box):

Regarding the group I retention force (N) at baseline and after several cycles in the Equator group, at baseline, the mean force in group I (Ot Equator with Smart Box) was 44.35 (±5.02) N; after 270 cycles (3 months), it was 20.12 (±5.06) N; and after 540 cycles (6 months), it was 8.65 (±4.99) N. A post hoc test showed that there was a statistically significant decrease in the mean retention force throughout all periods of follow-up. The OT-Equator with Smart Box group with medium retentive caps demonstrated equal initial and ultimate retentive probability values (P<0.001). (Table 1)

Group II (Novaloc attachment):

Regarding the group II retention force (N) at baseline and after several cycles in the Novaloc group, at baseline, the mean value in group II (Novaloc) was 18.90 (±5.86) N; after 270 cycles (3 months), it was 16.65 (±4.24) N; and after 540 cycles (6 months), it was 11.99 (±2.90) N. A post hoc test showed that there was a statistically insignificant decrease in the mean retention force after 270 cycles, while there was a significant decrease in the retention forces after 540 cycles. The Novaloc group with medium retentive caps demonstrated disparity in initial and ultimate retentive probability values (P>0.126) after 270 cycles and (P<0.002) after 540 cycles. (Table 2)

The retention forces of group I and group II were measured at baseline and during various cycles. At baseline, the mean N in Group I (Ot Equator with Smart Box) was 44.35 (±5.02); after 270 cycles (3 months), it was 20.12 (±5.06) N; after 540 cycles (6 months), it was 8.65 (±4.99) N. Regarding Group II (Novaloc), at baseline, the mean N was 18.90 (±5.86) N; after 270 cycles (3 months), it was 16,65 (±4.24) N; and after 540 cycles (6 months), it was 11.99 (±2.9) N. A post hoc test showed that there was a statistically significant difference in the mean retention force at baseline, while there was a statistically insignificant difference in the retention forces after 270 cycles and a statistically significant difference in the retention forces after 540 cycles. The initial and ultimate retentive probability values were P<0.001 at baseline, p>0.080 after 270 cycles, and p<0.046 after 540 cycles. (Table 3)

TABLE (1) Retention force (N) at baseline and after different cycles in the Equator group.

Medium retention	Baseline	270 cycles	540 cycles
Equator			
Range	38.20-52.50	8.83-24.30	2.65-18.50
Mean	44.35	20.12	8.65
SD	5.02	5.06	4.99
P value		0.001*	0.001*

P was considered to indicate statistical significance if ≤0.05
Comparisons were made between the baseline values and those obtained after 270 and 540 cycles.
**** Significant difference***

TABLE (2) Retention force (N) at baseline and after different cycles in the Novaloc group.

Medium retention	Baseline	270 cycles	540 cycles
Novaloc			
Range	11.00-31.50	9.86-22.80	7.78-17.80
Mean	18.90	16.65	11.99
SD	5.86	4.24	2.90
P value		0.126 N.S.	0.002*

P was considered to indicate statistical significance if ≤ 0.05

Comparisons were made between the baseline values and those obtained after 270 and 540 cycles.

**** Significant difference N.S. Not significantly difference***

TABLE (3) The two studied groups regarding retention force (N) at baseline and during different cycles.

Medium retention	Equator	Novaloc	P value
Baseline			
Range	38.20-52.50	11.00-31.50	0.001*
Mean	44.35	18.90	
SD	5.02	5.86	
270 cycles			
Range	8.83-24.30	9.86-22.80	0.080 N.S.
Mean	20.12	16.65	
SD	5.06	4.24	
540 cycles			
Range	2.65-18.50	7.78-17.80	0.046*
Mean	8.65	11.99	
SD	4.99	2.9	

P was considered to indicate statistical significance if ≤0.05

A comparison was performed between the equator and Novoc.

**** Significant difference***

N.S. = not significant

DISCUSSION

Implant-supported overdentures offer benefits such as increased function, aesthetics, patient satisfaction, and decreased residual ridge resorption. They use fewer implants and perform surgeries with less difficulty [28, 29]. In this research, an un-splinted implant overdenture was chosen due to its cost-effectiveness, ease of cleaning, and limited prosthesis space [30]. An in vitro investigation was also conducted to avoid individual variation and yield more accurate results. Epoxy resin was chosen for insertion due to its elastic modulus and strength during cyclic testing. The epoxy cast was split apart and filled with a layer of material mimicking mucosal tissues, after which a mandible replica was produced [28]. This finding was similar to the findings of the studies of Al-Ahmad et al. [31] and Masri et al. [32], who used simulated mucosa with a thickness of 2.5 to 3 mm. An adhesive was used to bond the underlying epoxy cast, ensuring a stable, immobile model surface simulating the mucous membrane.

The study used two implants under an overdenture, as the primary therapeutic choice in the edentulous mandible. The anterior jaw region was chosen due to high implant success with overdentures [33-35]. However, clinical practice and anatomical features may cause implants to tilt toward the ideal direction of denture insertion. The study placed two implants on each side in the canine region with a 15-degree distal inclination. This tilting makes it easier to place longer implants, shorten the cantilever, create better bone anchorage, and improve Antero-posterior spread. Supporting implants tilted also help distribute stress. Studies have found no significant difference between axially inserted implants and those tilted in terms of success, survival rates, bone loss, or stress [36, 37].

The study utilized a surgical guide created using CAD/CAM to insert two dummy implants bilaterally into the canine region, increasing Antero-posterior spread, decreasing cantilever length, and reducing stress on the implants. Tilted implants were successful, reducing treatment time, expenses, and morbidity associated with complicated surgical procedures [38].

The direct pick-up approach was used to attach attachments to the mandibular overdenture base, ensuring passive seating and reducing treatment time, expenses, and morbidity associated with complicated surgical procedures [39,40].

The study aimed to compare the changes in retentive force at 0, after 270 (3 months) and 540 (6 months) cyclic loading, simulated by insertion and removal cycles.

The study utilized a 90-degree jig to measure the retentive force of overdentures on a universal testing machine. A T-shaped metal plate was fixed over dentures, providing retentive force and load application. This design reduced measurement errors due to uncontrolled slack differences [25].

The universal testing machine was set at 50mm/min to simulate prosthesis removal during mastication[24]. Peak load to dislodgement was recorded using a computer. A cyclic tension-compression test was conducted to simulate inserting and removing overdentures. Each overdenture underwent 270-540 cycles, representing 3 and 6 months of insertion and removal cycles [10, 41].

The retention mechanisms, such as nylon inserts, can lose retention over time. This study compared resilient caps of OT-Equator and Novaloc attachments before and after cyclic loading. The study found that 540 cycles were adequate to achieve changes in attachment retention.

Considering its distinctive design, which includes an internal tilting mechanism for passive insertion with divergent implants up to 50 degrees, the OT-Equator with the Smart Box attachment was selected for assessment [42]. The attachment is composed of up of a titanium male abutment that is semispherical in form and has a strong titanium nitrite coating. It accommodates a nylon retentive insert with four retention levels and a stainless-steel retentive cap. Because to its tilting mechanism and rotating fulcrum, the Smart Box may be passively inserted even under diverging circumstances [43]. The elastic material used in the retention caps appears to perform better than stiff material [44].

Novaloc, a novel attachment system, uses a poly-ether-ether-ketone (PEEK) matrix on a cylindrical patrix for mechanical retention, potentially offering better durability than traditional nylon systems. Novaloc's higher rigidity and retentive forces align with previous research on peri-implant bone stresses [45].

Regarding the group I retention force (N) at baseline and after several cycles in the Equator group, compared to baseline, there was a statistically significant decrease in the mean retention force throughout all periods of follow-up, with 270 cycles (3 months) and 540 cycles (6 months).

Regarding the group II retention force (N) at baseline and after several cycles in the Novaloc group, compared to baseline, there was a statistically insignificant decrease in the mean retention force after 270 cycles (3 months), while there was a significant decrease in the retention force after 540 cycles (6 months).

The findings showed that, based on group I and group II's retention forces at baseline and throughout different cycles, the mean retention force at baseline differed statistically significantly, whereas the retention forces after 270 cycles were statistically insignificant and after 540 cycles, they were statistically significant.

The OT equator with smart box attachment had a higher initial retentive power than the novaloc attachment in the current study, according to the statistics. However, after 540 cycles of cyclic loading, the retentive power in the novaloc group was significantly higher than in the equator group.

In contrast to the null hypothesis, compared with OTs, Novaloc attachments had less primary retentive force but less significant deterioration in retention in the study group. This can be attributed to the fact that Novaloc has an amorphous diamond-like carbon (ADLC) coating on its patrix with a poly-ether-ether-ketone (PEEK) matrix compared to a highly frictional nylon component with an inner tilting mechanism in the OT Equator with smart box technology.

Given the present significance of attachments in dentistry, the results of this study demonstrate the advantages of prosthodontics. The necessity for more efficient, transformative methods is justified by the increased demand for patients with a history of dentures. Practitioners will therefore be able to treat patients more effectively if they follow the advice given by the study's findings.

CONCLUSION

The following conclusions can be drawn from this study:

1. Compared with the Novaloc attachment group, the OT-Equator with Smart Box Attachment group had favorable initial retentive force because of the use of a medium retentive cap.
2. Compared to those in the OT-Equator with Smart Box group, the final retentive force was greater in the Novaloc attachment group.
3. Mandibular overdentures supported by two implants used in conjunction with Novaloc attachment appeared to be a reliable and effective therapeutic option.

List of abbreviations

IAO : Implant-assisted Overdenture

CD : Completed Denture

DICOM : Digital Imaging and Communications in Medicine

CAD-CAM: Computer-aided Design-Computer-aided Manufacture

CBCT : Cone Beam Computerized Topography

STL : Standard Tessellation Language

DICOM : Digital Imaging and Communications in Medicine

PEEK : Poly(ether ether ketone)

UTM : Universal Testing Machine

SEM : Scanning electron microscopy

ADLC : Amorphous Diamond-Like Carbon

DECLARATIONS

Ethics approval and consent to participate

The study does not contain data from any individual or from human participants or from human data, human tissue, or animals.

Consent for publication

Not applicable

Availability of data and materials

Data supporting the study's conclusions may be obtained at Alexandria University's Faculty of Dentistry in Egypt. Although these data were utilised under licence for the current study, they are not publicly available, thus there are limitations on their availability. However, with consent from the Faculty of Dentistry at Alexandria University in Egypt, the authors can provide the data upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

No organization provided the writers any assistance for the work they submitted. The creation of this manuscript was not aided by any funding. This work was carried out without any financing.

Authors' contributions

A.A., S.A., and M.B. designed the study. A.A. gathered the relevant information. S.A. carried out the study plan, while M.B. analyzed the retention and wear pattern results. A.A. evaluated the data and prepared the manuscript draft. S.A. and M.B. revised and edited the manuscript. All the writers approved the final manuscript.

ACKNOWLEDGMENTS

I would like to thank Dr. Sherif for his invaluable guidance and support throughout this project. I am also grateful to my research assistant, Dr. Mohamed, for his dental expertise and assistance. Finally, I would like to acknowledge the institutions that generously helped me with that work.

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