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Effect of Different Positions of Dental Implants Supporting Mandibular Overdentures on The Denture Retention

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ABSTRACT

Aim: The purpose of this study was to assess the impact on denture retention of various placements of dental implants supporting mandibular overdentures, including both interforaminal and posterior areas. **Materials and Methods:** Based on predetermined criteria, ten male patients who were completely edentulous were chosen from the prosthodontic departments Outpatient Clinic at Future University Faculty of Oral and Dental Medicine. Two equal groups of five patients each were randomly selected. Each patient received four mini-implants positioned in various locations (interforaminal, as well as both interforaminal and posterior areas). Group I (Patients rehabilitated using overdenture retained by four mini dental implants positioned in the interforaminal region). Group II (Patients rehabilitated using overdenture retained by four mini dental implants positioned in the posterior and interforaminal regions). The protocol for early loading was applied. A Forcemeter device was used to measure retention in all cases, first at zero months, then at one month, and finally at two months following denture insertion. Data were gathered, verified, edited, tabulated, and subjected to a student t-test statistical analysis.. **Results:** When comparing the two groups over the study, the findings show that denture retention was not significantly impacted by the location of the dental implants. **Conclusion:** In patients who are completely edentulous, mini dental implants may be utilized as an alternative to traditional implant-retained overdentures utilizing early loading protocol. Denture retention was not significantly impacted by the location of the mini dental implant supporting the mandibular overdenture.

KEYWORDS

Mini implant position, mini dental implant, edentulous mandible, overdenture, denture retention.

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INTRODUCTION

In the last four decades, numerous strategies have been introduced to over come the challenges resulting from by wearing a mandibular denture and the ongoing resorption of the alveolar ridges. When employing traditional denture techniques, achieving stability and retention of the mandibular denture can be difficult.

Clinicians have known for a long time that placing endosseous osseointegrated implants beneath a removable prosthesis has many advantages including increased denture stability, comfort, occlusal support

and bone preservation. So that, this treatment option has improved quality of life and is now often elective. Overdentures held in place by implants are becoming a common substitute for fixed prosthetics supported by implants. This is because patients with poor motor coordination can access adequate oral hygiene, and it also enhances their aesthetic experience and preference.

For patients who are completely edentulous but have compromised teeth, implant-supported overdentures can be a helpful treatment option. Their affordability, minimal invasiveness, and relative simplicity make them an especially appealing treatment option. When the anatomy of the jaw prevents the application of a traditional implant without beneficial surgical procedures, small diameter implants, or mini dental implants, can often be used as a therapeutic substitute. The use of mini dental implants (MDIs), which are biocompatible titanium screws with an incredibly mini diameter (1.8–2.4mm), for immediate overdenture stabilization has shown promise. **(Shatkin et al 2007 , Ahn et al 2004 , Griffitts et al 2005 , Jofre et al 2010).**

Jae-Hoon et al. 2005 has defined implant diameter as the length measured between the widest thread peak and the same point on the implant's opposing side. Mini implants are defined as implants that have a diameter of 2.7 mm or less, which is smaller than that of narrow regular implants.

Christensen GJ. **2006 and** ***Shatkin*** **et al 2007** Victor I. Sendax is the creator and designer of mini implants, which are biocompatible titanium screws with a minuscule diameter of 1·8–2·4 mm.

Coelho de Aguiar et al. 2012 stated that by removing pressure from the permanent implants, these implants aid in the healing process. They would also allow for the assessment of the temporary fixed prosthesis's vertical dimension, phonetics, and aesthetics during the healing period, which would cut down on the amount of time typically needed for this evaluation after the typical 4-6 month healing period.

The resistance of the denture to be removed in direction opposite to its insertion or the resistance of the denture to move away from its tissue foundation, particularly in a vertical direction, is known as retention. ***(The Academy of Prosthodontics 2023)***

Stress/strain magnitude surrounding implants can be greatly influenced by implant overdenture attachment design and dislodging forces; the more resilient the attachments are to dislodging forces, the greater the transferred stresses. ***(ElKerdawy and Radi 2011)***

The authors arrived at the conclusion that prosthesis selection should take into account the distinct retentive forces and strain energies of implant overdenture stud attachments after comparing their effects on an implant-retained in vitro overdenture model. ***(Petropoulos and Mante 2011).***

About 20 years ago, the first immediate function procedures were performed, and they primarily addressed the chin symphysis, a mandibular region with a high bone density. Numerous clinical studies have verified the effectiveness of the technique used on the anterior mandible, but some doctors have argued that it may be possible to intervene in areas such as the upper arch or, in certain situations, the posterior mandible where the bone quality is not as good. As a result, it was determined to be beneficial to assess how various placements of mini dental implants supporting mandibular overdentures affected denture retention.

AIM OF THE STUDY

The purpose of this comparative study was to assess the impact on denture retention of various placements of mini dental implants supporting mandibular overdentures, including both interforaminal and posterior areas.

MATERIAL AND METHODS

Ten male patients who were completely edentulous were chosen based on the following parameters from outpatient clinic of Prosthetic Department, Faculty of Oral and Dental Medicine, Future University:

- No systemic or incapacitating diseases that could compromise bone quality, post-operative healing, or implant osseointegration were present in the patients.
- The patient was in the 45–65 age range.
- The patients exhibited normal maxillo-mandibular relationship (Angle class I), sufficient interarch distance, and no tempromandibular joint disorders.
- The edentulous ridges lacked flabby tissue or severe bony undercuts, and they were covered in a robust, healthy mucosa.
- Individuals with poor oral hygiene or bad habits (such as clenching or bruxism) were not accepted
- Patients with radiation therapy to the head and neck area or heavy smokers were not allowed to participate in this study.
- The chosen patients were made aware of the purpose of the study. After completing a written consent form, only cooperative, motivated patients took part in the study. Every patient received a thorough examination. It comprised radiographic examination, extra-oral and intraoral examination, medical history, dental history, and personal data.

- **Diagnostic cast preparation**

To create diagnostic casts, impressions of the upper and lower alginate were taken and then poured into dental stone. There was a tentatively observed centric jaw relation. The casts were put on an articulator in order to assess the ridge relationship and available interarch space, which varied from 12 to 15 mm.

Patients were divided into two equal groups (five patients each) according to the position of mini dental implant:

Group I: Four mini dental implants were used to stabilize an overdenture in the interforaminal region for patients undergoing rehabilitation.

Group II: Four mini dental implants were used to stabilize an overdenture in the posterior and interforaminal regions of patients undergoing rehabilitation.

- **Patients had received complete dentures according to the conventional technique.**
- **Surgical procedures for implant installation:**

1. ***Radiographic template and surgical stent construction***

Using alginate impression material, the mandibular denture was replicated into clear acrylic resin. This duplicate served as both a surgical and radiographic template. The fitting surface of the template was then used to drill cavities 5 mm deep, corresponding to the implant position. Sticky wax was used to insert metal balls (4 mm in diameter) into these cavities. So that, the following equation could be used to determine the actual bone height there: Radiographic bone height × metal ball diameter equals actual bone height. The metallic ball's diameter on radiography

Following the removal of the metal balls and drilling of holes at the designated implant sites, the surgical stent was kept in a 0.2% chlorhexidine solution until the procedure.

2. ***Presurgical medication***

Patients were given an umbrella prescription of broad spectrum antibiotics for infection control

twenty-four hours prior to the surgical procedure, to be taken as one tablet every eight hours. Patients were also asked to continue taking the antibiotics for one week in order to prevent any potential infections. The patient received one capsule of non-steroidal anti-inflammatory drug *** * twice a day for three days. One day prior to surgery, mouthwash containing chlorohexidine ****** was used three times a day.

3. *Implant selection*

In this investigation, a single-piece screw-type mini-implant with a diameter of 2.5 mm and a length of 10 mm was utilised.

4. *Surgical procedure*

Using articaine anaesthesia, bilateral mental nerve block anaesthesia and ring infiltration anaesthesia were administered at the site corresponding to the surgical field ********. Using an indelible pencil, the surgical stent was placed into the patient's mouth to mark the locations of the four implants (Figs. 1 and 2). Using a single, 1.6mm diameter, 10-mm-long guide drill and generous irrigation, the flapless technique was used to create an osteotomy that was smaller than the implant's dimensions. This procedure was repeated for each implant.

The osteotomies were checked for parallelism using paralleling pins. One mini-implant was carefully inserted using the holding cap into one of the prepared osteotomy sites after being taken out of its sterile packing. After that, the mini-implant was gradually turned clockwise while applying light apical pressure. After being initially inserted halfway into the osteotomy site and removed, the cap becomes deformed. After that, the implant was inserted manually until some resistance was felt. In the end, the implant's head protruded above the mucosa when it was threaded to its full length using the Ratchet * (Fig. 3 and 4). The same procedure was repeated for the other three implants

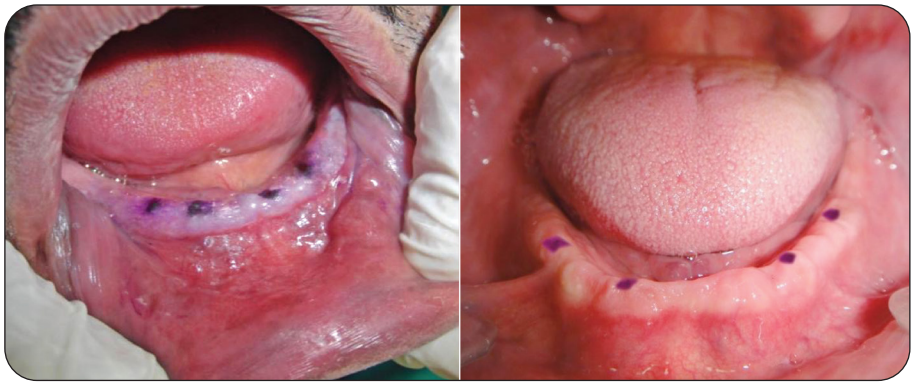

Fig. (1&2) The implant sites marked intra-orally for group I (left) and for group II (right)

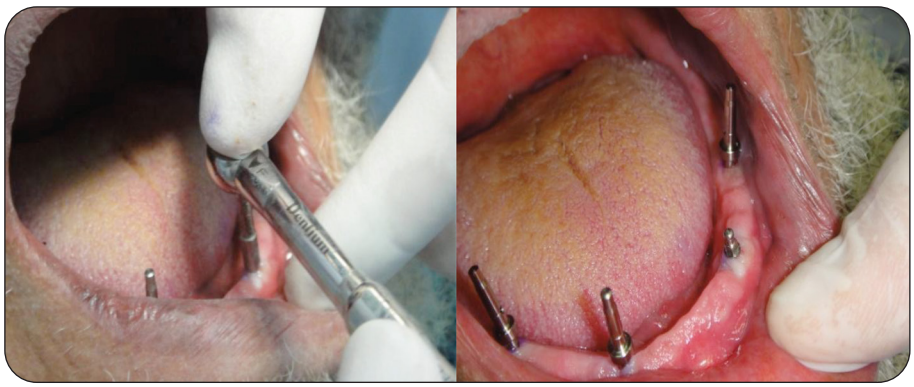

Fig. (3&4) The mini-implant that was installed for groups I (B) and II (D), with its head protruding above the mucosa, and the ratchet that was used to fully install the implant (a and b).

-Pick-up procedures and denture delivery Using rubber rings, the undercut regions surrounding the mini-implant heads were carefully sealed off. The mini-implants were fitted with metallic housing caps and rubber O-rings. The denture's fitting surface was marked with the areas that oppose the housings. A sufficient quantity of resin was eliminated in designated regions until a gap of approximately 1-2 mm was created surrounding the metal containers. In order to ensure that the mandibular denture was completely seated and not rocking, it was placed into the patient's mouth. Next, two holes were made in the lingual acrylic flange beneath the prosthetic teeth.

In the dough stage, self-cured acrylic resin was combined and applied to the fitting surface's relieved areas. After the patient was given instructions to close in centric occlusion, the mandibular denture was repositioned in their mouth. The denture was taken out of the patient's mouth and the metal housings and O-rings were picked up after the polymerization process was finished. The extra material was cut away with a finishing stone. Following post-insertion instructions, the patient received the re-polished mandibular denture.

- **Then the following instructions were given to each patient:**

- Not to touch the implants.
- Eat soft food only until the next appointment.
- To strictly comply with the prescribed medications.
- Contact in case of any pain, or exudates around the implants or any other unusual symptoms.
- Patients were recalled one, 2 months after delivery and pick-up procedures for measuring the denture retention.

- **Measuring the denture retention**

A. Identification of the geometric center:

First, the relative geometric centre of the lower denture was located; wax was used to block any undercuts in the denture's fitting surface. The lower denture's fitting surface was then filled with a plaster mixture, and the cast's base was built using a different mixture (Fig. 5). On the denture, the midline and the centres of the retromolar pads were marked. These markings were connected by cutting a piece of cardboard, creating a triangle. The geometric centre of the triangle was defined as the point where the three lines that divide its three angles intersect (Fig. 5).

The triangle's geometric centre was then determined using scientific principles. The intersection of all straight lines that split a plane figure into two parts of equal moment about the line is known as the geometric centre of the figure in geometry. It is, informally, the "average" of all the figure's points.

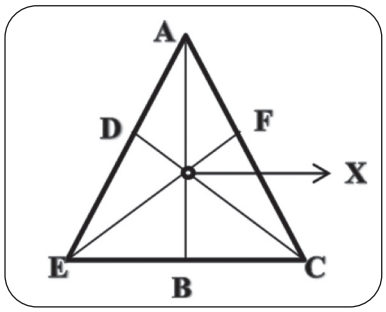

Fig. (5) The centered (geometric center) of this triangle would be x= intersection of AB. CD and EF.

To mark it on the cast, a pin was inserted through the cardboard at the downward geometric centre. To keep the predefined centre in place, a plastic rod was attached to the cast and suspended upward from the indicated point. To help the wires stay in place during the retention measurement procedures, V-shaped grooves were made on the lower denture's polished surface. The study employed wrought wires with a diameter of 1 mm, which allowed for sufficient thickness to withstand deformation during testing procedures. In order to avoid invading the tongue space, the wrought wires were adjusted to run 2 cm above the occlusal plane. (Fig.6)

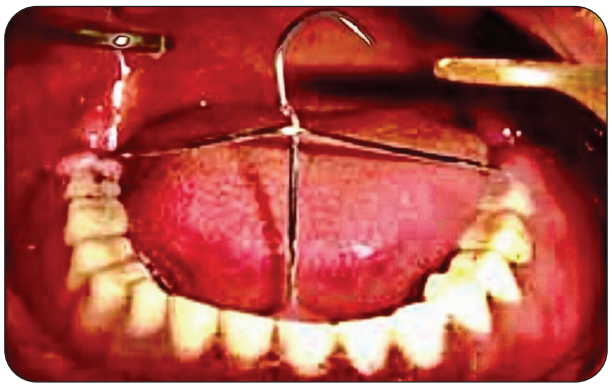

Fig. (6) Wire hook attached to the Lower denture

This was necessary to keep the lower denture stable throughout the measurement process. In order to engage the forcemeter knife and enable the denture to be lifted, the second wire's end was bent into a C-shaped loop (Sadek 2010). After that, self-curing acrylic resin was used to secure the wire ends to the lower denture's polished surface. After that, extra acrylic resin was eliminated, and the surface was polished and refinished. After that, the patient's lower denture was placed inside their mouth to assess denture stability, tongue freedom, and loop position.

B. Steps for retention measurement procedure:

The patient's mouth was fitted with a wired lower denture. The patient was positioned so that his head was properly supported and the occlusal plane of mandibular denture was parallel to the floor while he was sitting upright. A specialised forcemeter machine—a digital tool with the ability to gradually apply vertical force in both upward and downward directions at a specific point—was used to measure retention. The testing device can read zero at the minimum and three thousand grammes at the maximum. The device is made up of a metallic probe that is wired to a base. Applying force is done with the metallic probe. The Probe's thickness is 1.5 mm and width 6 mm. A digital screen on the base displays values in both positive and negative directions based on the direction of force applied. (Fig.7)

By pulling on the metallic loop in the denture's geometrical centre until it disengages, the device measures the retentive farce of lower overdentures. The magnitude of force that cause the lower denture to become loose was noted. There were twenty iterations of the process. After removing the highest and lowest readings, the mean of the remaining eighteen readings was determined. The patient's lower denture was then removed. The cables were taken out. Acrylic resin that self-cured was used to refill the grooves. After that, these sections were polished and refinished.

Fig. (7) Application of dislodging force

Statistical analysis

Data were collected, checked, revised, tabulated and entered into the computer. Quantitative variables from normal distribution were expressed as mean and standard deviation (SD) values.

Statistical Analysis was performed with IBM ® SPSS ® Statistics Version 20 for Windows.

RESULTS

Every patient was present until the conclusion of the observation period. Regarding retention, stability, and function, all patients in both groups expressed satisfaction with the prosthesis that was delivered. Tables 1 through 4 present the results. The mean and standard deviation (SD) values

of the data were displayed. The student's t-test was employed to compare the two sets of data. To examine the changes over time within each group, a paired t-test was employed. Since the retention data's percentage decrease indicated a non-parametric distribution, the Mann-Whitney U test was employed to compare the two groups. A significance threshold of $P \leq 0.05$ was established. For statistical analysis, IBM® SPSS® Statistics Version 20 for Windows was used.

Comparison between the two groups

The mean retention values in the two groups did not differ statistically significantly at the time of insertion, one month later, or two months later.

Table (1) *The mean, standard deviation (SD) values and results of Student's t-test for the comparison between retention values in the two groups*

Time \ Group	Group I		Group II		*P*-value
	Mean	SD	Mean	SD	
At insertion	329.4	22.9	344.4	31.7	0.417
1 month	320.3	10.8	329.6	21.8	0.418
2 months	314.9	16.2	327.7	11.5	0.189

**: Significant at $P \leq 0.05$*

Changes by time in each group

Anterior position group

After 1 month, there was a non statistical difference in mean retention values.

After 2 months, there was a statistically significant decrease in mean retention values.

Posterior position group

For both 1 and 2 months, the mean retention values was decreased but with no statistical significant difference.

Table (2) *The mean, standard deviation (SD) values and results of paired t-test for the changes by time in retention values of anterior position group*

Time	Mean difference	SD	*P*-value
At insertion – 1 month	-9.1	7.9	0.319
At insertion – 2 months	-14.5	7.5	0.013*

**: Significant at $P \leq 0.05$*

Table (3) *The mean, standard deviation (SD) values and results of paired t-test for the changes by time in retention values of posterior position group*

Time	Mean difference	SD	*P*-value
At insertion – 1 month	-14.8	12.9	0.443
At insertion – 2 months	-16.7	11.5	0.230

**: Significant at $P \leq 0.05$*

Comparison between percentage decreases in retention of the two groups

The percentage decrease was calculated as:

$$\frac{\textbf{Retention (At insertion)} - \textbf{Retention (Post-insertion)}}{\textbf{Retention (At insertion)}} \times 100$$

After 1 month as well as after 2 months; there was no statistically significant difference between the two groups.

Table (4) *The mean %, standard deviation (SD) values and results of Mann-Whitney U test for the comparison between % decreases in retention of the two groups*

Time \ Group	Group I		Group II		*P*-value
	Mean %	SD	Mean %	SD	
At insertion – 1 month	2.5	5	3.7	2.3	0.754
At insertion – 2 months	4.3	2	4.4	7.1	0.917

**: Significant at $P \leq 0.05$*

DISCUSSION

A complete denture treatment's success largely depends on retention. The most common issue with current conventional complete dentures is lack of retention. This makes it difficult for the patient to eat and socialise because they are afraid of losing their dentures. ***(Naert et al. 1988).***

The mini-implants used in this study have a number of benefits. Their installation is a minimally invasive, flapless process that reduces bleeding, minimises postoperative discomfort (which is typically linked to flap surgery), speeds up healing, and lowers the risk of infection during the surgical procedure. It is a preservation technique used to restore patients with atrophic mandibles without the need for potentially problematic bone augmentation surgery. ***(Gibney 2001; Campelo and Camara 2002).***

In terms of retention, stability, and masticatory function, all patients expressed subjective satisfaction with their restorations. This suggests that overdentures supported by four mini-implants might be regarded as a workable and trustworthy course of therapy. Based on the patients' improved masticatory function, it appears that four mini-implants were sufficient to provide the prosthesis with the necessary retention, stability, and support. The subjective conclusions drawn by ***Griffitts et al. 2005***, who additionally supported the mandibular and maxillary overdentures with four mini-implants. They actually stated that their clinical study's high success rates and overall excellent patient satisfaction were so impressive that they now consider this procedure to be a more viable surgical option than two traditional implants with a ball and socket attachment or a bar. Given that mini-implants are less expensive than traditional implants and that their surgical process is less complicated, takes less time, and is linked to fewer post-operative complications, a new avenue for treating patients who desire and seek implant therapy but are sadly unable to pay for it has opened.

Furthermore, the following facts are relevant:

- The six normal directions in which overdenture movement happens are occlusal, gingival, mesial, distal, facial, and lingual. In the interim, it is important to remember that real unidirectional dislodging forces are uncommon in clinical settings.
- It is generally accepted from earlier attachment studies that retentive force will eventually diminish. The wear of attachment components, which may be connected to deformation that happens during prosthesis insertion and removal, has been blamed for this loss of retention. *(Alsabeeha et al 2009)*.

During this recent study the following was found:

- The statistical results in table (1) indicated that the mean retention values of the two groups did not differ in a way that would be considered statistically significant, indicating that the retention rates of both groups were constant over the course of the study. This could be explained by the fact that both groups employed the same kind of attachment.
- The statistical results in table (2) indicated that the mean retention values for Group I decreased statistically significantly in the second month, whereas the statistical results in table (3) indicated that Group II mean retention values did not decrease statistically significantly. This could be explained by the fact that group I experiences more O-ring wear around the abutments than group II, which could be connected to the latter group's distribution of mini implants, which increase denture stability and reduce O-ring wear.
- The statistical results in table (4) indicated that the percentage decrease in retention for both groups was not statistically different, indicating that the percentage decrease in retention is the same for both groups. This finding may be related to the brief follow-up period.

CONCLUSIONS

Within the limitation of this comparative study, the following conclusions were made:

- In patients who are completely edentulous, mini dental implants may be utilized as an alternative to traditional implant-retained overdentures and dentures.
- Mandibular overdentures supported by mini-implants may be loaded early, which is a viable and practical treatment option.
- Denture retention was not significantly impacted by the location of the mini dental implant supporting the mandibular overdenture.

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تأثير المواضع المختلفة لزراعة الأسنان الداعمة للأطقم السفليه المحمولة على تثبيت طقم الأسنان

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الملخص :

الهدف: كان الغرض من هذه الدراسة هو تقييم التأثير على ثبات أطقم الأسنان بالمواضع المختلفة لزراعة الأسنان التي تدعم أطقم الأسنان السفلية المحمولة، بما في ذلك المناطق البينية والخلفية .

المواد والاساليب: بناءً على معايير محددة مسبقًا، تم اختيار عشرة مرضى ذكور كانوا عديمي الأسنان تمامًا من العيادة الخارجية لقسم التعويضات السنية في كلية طب الفم والأسنان بجامعة المستقبل. تم اختيار مجموعتين متساويتين من خمسة مرضى بشكل عشوائي من بين المرضى. تلقى كل مريض أربع غرسات صغيرة موضوعة في مواقع مختلفة (بين الثقبين الذقنيين، وكذلك المناطق بين الثقبية والخلفية). المجموعة الأولى (المرضى الذين تم إعادة تأهيلهم باستخدام طقم الأسنان المحمول الذي تم الاحتفاظ به بواسطة أربع زرعات أسنان صغيرة موضوعة في المنطقة البينية). المجموعة الثانية (المرضى الذين تم إعادة تأهيلهم باستخدام طقم الأسنان المحمول الذي تم الاحتفاظ به من خلال أربع عمليات زرع أسنان صغيرة متمركزة في المناطق الخلفية وبين المناطق البينية). تم تفعيل بروتوكول التحميل المبكر. تم استخدام جهاز «FORCEMETER" لقياس قوة الثبات في جميع الحالات، أولاً عند صفر شهر، ثم بعد شهر واحد، وأخيراً بعد شهرين من إدخال طقم الأسنان. تم جمع البيانات والتحقق منها وتحريرها وتبويبها وإخضاعها للتحليل الإحصائي لاختبار الطالب

النتائج : عند مقارنة المجموعتين خلال الدراسة، أظهرت النتائج أن قوة ثبات الأطقم المحمولة لم يتأثر بشكل كبير بموقع زراعة الأسنان

الخلاصة: في المرضى الذين ليس لديهم أسنان كاملة، يمكن استخدام زراعة الأسنان الدقيقة كبديل للأطقم التقليدية التي يتم الاحتفاظ بها بالزرع باستخدام بروتوكول التحميل المبكر. لم يتأثر الاحتفاظ بثبات الأطقم بموقع زراعة الأسنان الصغيرة التي تدعم أطقم الأسنان المحمول في الفك السفلي

الكلمات المفتاحية : وضع الغرسات الدقيقة، الغرسات الدقيقة ، فك سفلى خالي من الأسنان ، طقم محمول ,ثبات الطقم