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Comparative study between cement retained and screw retained implant prosthesis radiographically, clinically and biochemical levels of IL-1β and MMP-9 in PICF

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ABSTRACT

Aim: Aim of this study was to compare between cement retained versus screw retained prothetheis on dental implant. **Subjects and Methods:** Eleven patients with 22 missing teeth were randomly divided into two groups. Group (I) 11 sites with single missed tooth received an implant then cement retained prosthesis. Group (II) 11 sites with single missed tooth received an implant then a screw retained prosthesis. Clinical and biochemical parameters were taken at baseline 1 and 3 months while radiographic parameters were taken at baseline, 1 and 6 months. **Results**: both groups showed a non-significant difference in mPI, mBI , PIPD and BD. Cement retained group showed higher bone loss than screw retained ($p=0.002$) ($p<0.001$) respectively. IL-1β and MMP-9 showed increased expression in peri-implant crevicular fluid around cement retained more than screw retained prosthesis. **Conclusion**: screw-retained implant prothehesis gives better result from biological point of view than cement-retained implant prosthesis.

KEYWORDS

Cement retained, Screw retained, IL-1β , MMP-9, Dental implant.

INTRODUCTION

The dawn of the implant era in dentistry has generated an endless debate among clinicians on the ideal type of implant prosthesis retention. Historically, screw-retained prosthesis were first introduced for use with osseointegrated titanium implants, but the ease of restorability along with a wider margin for error in implant positioning allowed cement-retained prostheses to dominate during the 2000s. A single type of retention is not usually used in clinical cases rather than attempting to personalize treatment planning for each case[1] .

The advantages of the cement retained prosthesis, including its greater versatility for aesthetics and simplicity of the technique. The absence of a screw to draw inadequately fitting components together with a clamping force would be likely to eliminate strain that the

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tightening force of the screw would introduce into the restoration/implant assembly. These potential advantages have made cement retained implant prostheses increasingly popular [2] .

The main objective of this study was to evaluate radiographic, clinical and biochemical parameters around cement and screw retained prosthesis.

PATIENTS AND METHOD

This study was designed as split mouth randomized clinical study, conducted on 11 patients (9 females and 2 males aged from 20-40 years) with bilateral missing single isolated tooth seeking for receiving dental implants. They were selected from the outpatient clinic of Oral Medicine, Periodontology, Oral Diagnosis and Dental Radiology Department, Faculty of Dental Medicine, Al-Azhar University (Assiut branch)..

All patients had signed informed consent form after being fully informed about study protocol, treatment plan, and alternative treatment approaches.

Eligibility criteria

Inclusion criteria for participants:

All patients were free from any systemic diseases according to the American dental academy general guidelines for referring dental patients to specialists and other setting for care[3] . Patients with bilateral isolated missing single tooth. The implant sites had opposing natural teeth, not drifted, malposed or over erupted to the implant site. Patients were cooperative, motivated, and had good oral hygiene.

Exclusion criteria for participants:

Patient with severe skeletal discrepancy and para functional habits[4] . Patients who had already received or lost implants in the potential implantation site. Heavy smoker's patients, alcohol or drug abused[5] . Patients with lack of compliance to oral hygienic homecare [6]. Patient who in need for significant bone augmentation

Sample size

The sample size calculation, the power analysis was performed using G power system for a one-way fixed effects analysis of variance (ANOVA). The criterion for significance was set at A= 0.005 (Type1 error) and B =0.20 (type II error). The sample size was determined as 9 cases per group.

Patients grouping and intervention:-

After assessment of the prospective maximum height of the future restoration that may decide the type of the restoration for, the patient's sides were classified randomly into two equal groups using coin flipping technique, and total of 22 implants were placed in the selected sites.

- Group I: 11 sites with single missed tooth received an implant then cement retained prosthesis.
- Group II: 11 sites with single missed tooth received an implant then a screw retained prosthesis.

Surgical procedure

Before surgery, all patients' mouths were rinsed with 20 ml chlorhexidine gluconate 0.12% solution for 30 second as a topical antimicrobial agent. A surgical site was locally anaesthetized by 40mg/0.01mg/ml (Articaine hydrochloride+ Epinephrine (adrenaline)). A 15 blade was used to make a crestal incision was done, and full thickness flap was reflected, which elevated and extended under the anticipated apical extension of the preplanned implant length. The site preparation for implants began with site marking. Then, a 1.5-mm initial pilot osteotomy was created with a pilot drill rotated at 1200 RPM in a clockwise rotation to the wanted depth utilizing a high speed surgical handpiece and a surgical motor. Using paralleling pins, an X-ray was taken to confirm the angulation between the adjacent teeth and the implants. Once the correct position of the implant was confirmed. Sequential use of drills in cutting clockwise direction at 1200 RPM to prepare the osteotomy site

to the wanted diameter. Incremental drilling was done using progressively larger drill sizes. Insertion of the implants fixture (SGS®) was achieved according to manufacture instructions. Careful screwing and seating of these tapered implants into the bone was performed until all exposed threads were submerged and the platform remained flush with the crestal bone with gaining primary stability of the implants and fixation in its position and implants were evaluated for primary stability. The surgical wounds were sutured by 3.0 silk to achieve primary closure. Radiographic evaluation was done by periapical x ray.

Second stage surgery

After 4-6 months for osseointegration, a crestal incision was done to expose the implant fixture. A healing abutment is placed, a healing period of 2 weeks was enough to start the prosthetic phase for each group either cement or screw retained. After second-stages surgery, it was decided whether the implant received a cemented or screw retained, using the following process: The prospective maximum height of the future restoration was calculated graduated periodontal probe measuring the shortest distance from the healing abutment to the fissure line of the opposing tooth. Which may affect the decision in choosing one of the retention methods (because screw retained prosthesis in indicated in interocclusal space less than 4mm). Two subjects with a similar prospective height were paired and the type of suprastructure (cement-or screw-retained) was randomly assigned to those implants using the coin flipping technique.

Prosthetic phase

Cemented group

Standard titanium abutments (SGS Ready Made S2 Straight abutment, gingiva heights 9 mm) were customized chair side. For this purpose, they were inserted intraorally, and the potential height reduction required and correct finish line were marked with a pencil. The modifications were immediately performed chairside by fixing the abutments to a laboratory implant analogue. The preparation margin was located slightly subgingival (≤1.0 mm) in the visible area. The abutments were re-inserted, and additional silicon impression were taken for the fabrication of the cemented monolithic zirconia crowns. Prior to insertion, the maximum height of the abutment and the entire height of the abutment and crown together were measured with a slide gauge. Finally, the crown was adhesively luted intraorally using Glass ionemer cement. Cement residues were removed with hand scalers using a dental microscope.

Screw retained group

After placement of the abutment and additional silicon impression is taken and sent to the laboratory for crown fabrication and virtually designing the monolithic restoration, it was milled from monolithic zirconia crowns block with a prefabricated hole and a notch. After try-ins (before and after crystallization, staining, and glazing) the monolithic restoration was adhesively luted extraorally to the corresponding titanium base according to the manufacturer´s recommendations. The total height of the restoration, including the seat of the titanium base, was measured. The coronal part of the occlusal screw canal was etched with fluoric acid. Then, the restoration was inserted definitively with a torque of 20 N/cm. The screw canal was rinsed with ethanol, dried, and covered with a polytetrafluoroethylene (PTFE). The screw canal was silanized, and the occlusal access was closed with flowable composite.

Assessment

- CBCT was used to evaluate bone density, height of marginal bone from alveolar crest to implant shoulder. Residual bone height using periapical radiograph in (mm) preoperatively. All radiographic parameters were taken after baseline, 1 and 6 months.
- Clinical (mPI ,mBI and PIPD) and biochemical (IL-1β and MMP-9 levels) parameters were taken after baseline, 1 and 3 months.

Case presentation (Cement retained group)

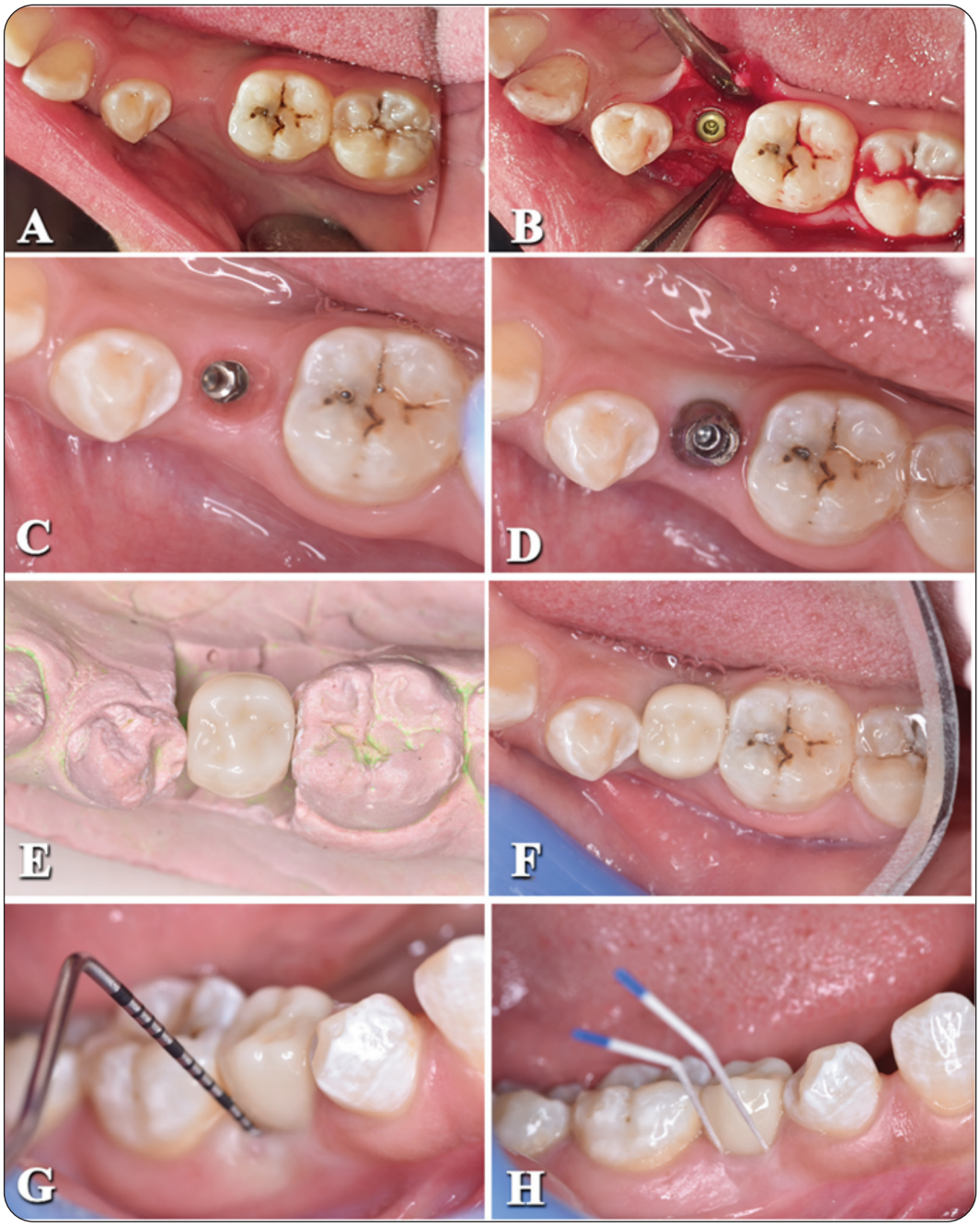

Fig. (1) Clinical photos representing cement retained group for tooth number "45" in a female 22 years old, showing:

(A) Pre-operative situation (B) Implant placement (C)Soft tissue healing after gingival former (D) Stock abutment in place (E)Crown delivery on cast (F)Crown cementation (G)PIPD measurement after 1 month (H)PICF collection after 3 months.

Case presentation (Screw retained group)

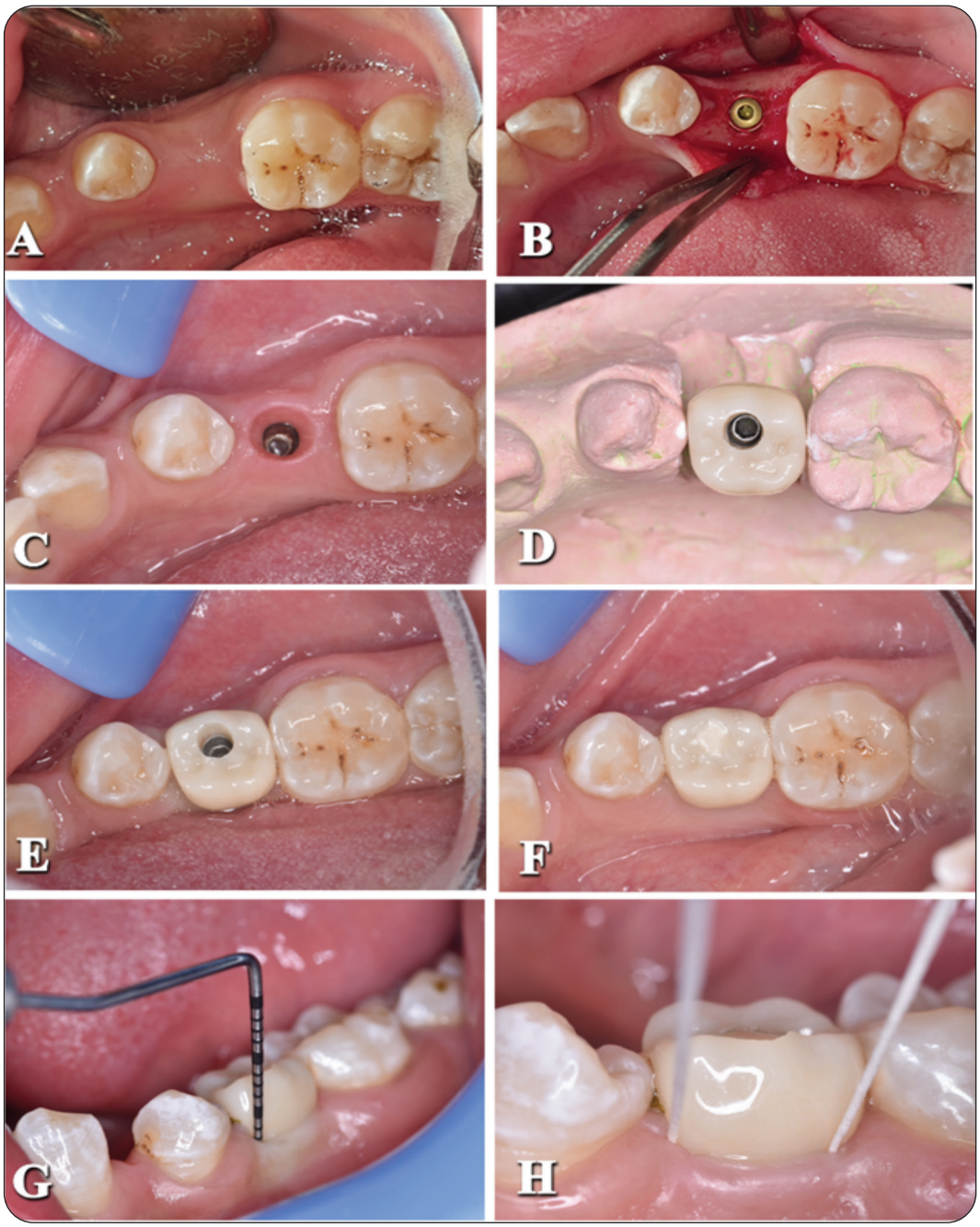

Fig. (2) Clinical photos representing screw retained group for tooth number "35" in a female 22 years old, showing:

(A)Pre-operative situation (B)Implant placement (C)Soft tissue healing after gingival former (D) Crown delivery on cast (E)Screw retained crown in place with open access hole (F)Access hole closure using composite (G)PIPD measurement after 1 month (H)PICF collection after 3 months.

Follow up and data collection

Clinical parameters

Modified plaque index, modified bleeding index and peri-implant probing depth were measured at baseline, 1 and 3 months after prosthetic phase.

Radiographic parameters

CBCT and periapical radiographic examinations were performed after 2 weeks from prosthetic phase as a baseline, 1 and 6 months. This had included measurements of marginal bone loss and recording bone density value around implants.

Biochemical parameters

Levels of IL-1β, MMP-9 were measured at baseline, 1 and 3 months

Measuring of bone density:

The change in bone density around implant was measured in Hounsfield units using BlueSky Bio. (software) (HU). On buccal, lingual, mesial, and distal sides of implant, measurement sites were positioned at top, middle, and apical parts. The average density was calculated using mean values of bone density along each side implant. This procedure was carried out at each postoperative follow-up interval.

Statistical analysis:

Numerical data were presented as mean and standard deviation values. The data were collected; tabulated and statistical analysis was performed, with International Business Machines (IBM) Statistical Package for Social Sciences (SPSS) statistics version 20 for Windows. The significance level was set at P-value ≤ 0.05. Graphs were performed using the Microsoft Excel 2016 program.

RESULTS

I. Clinical parameters:

There was no statistically significant difference between cement-retained group and screw retained group at baseline, 1 and 3 month. (Table 1, 2,3)

Table (1) *The mean ± standard deviation (SD) and p-values of mPI score of both groups.*

Variables	mPI								
	Group I (Cement retained)				Group II (Screw retained)				p-value
	Mean	SD	Min	Max	Mean	SD	Min	Max	
Baseline	0.50 ^{abA}	0.53	0.00	1.00	0.50 ^{abA}	0.53	0.00	1.00	**1ns**
After 1m	0.30 ^{bA}	0.48	0.00	1.00	0.30 ^{bA}	0.48	0.00	1.00	**1ns**
After 3m	0.80 ^{aA}	0.42	0.00	1.00	0.80 ^{aA}	0.42	0.00	1.00	**1ns**
p-value	**0.022***				**0.022***				

Table (2) *The mean ± standard deviation (SD) and p-values of mBI score of both groups.*

Variables	mBI								
	Group I (Cement retained)				Group II (Screw retained)				p-value
	Mean	SD	Min	Max	Mean	SD	Min	Max	
Baseline	0.85 ^{aA}	0.34	0.50	1.50	0.65 ^{aA}	0.34	0.00	1.00	**0.242ns**
After 1m	0.70 ^{aA}	0.26	0.50	1.00	0.75 ^{aA}	0.26	0.50	1.00	**0.661ns**
After 3m	0.85 ^{aA}	0.34	0.50	1.50	0.80 ^{aA}	0.26	0.50	1.00	**0.796ns**
p-value	**0.459ns**				**0.368ns**				

Table (3) *The mean ± standard deviation (SD) and p-values of PIPD in mm of both groups.*

Variables	PIPD								
	Group I (Cement retained)				Group II (Screw retained)				p-value
	Mean	SD	Min	Max	Mean	SD	Min	Max	
Baseline	2.05 ^{bA}	0.25	1.50	2.30	1.74 ^{bA}	0.25	1.50	2.16	**0.050ns**
After 1m	2.17 ^{bA}	0.23	1.80	2.50	2.10 ^{aA}	0.28	1.50	2.60	**0.558ns**
After 3m	2.41 ^{aA}	0.41	1.60	3.10	2.14 ^{aA}	0.32	1.50	2.50	**0.128ns**
p-value	**0.037***				**0.011***				

Means with different small letters in the same column indicates significant difference, means with different capital letters in the same row indicates significant difference

**; significant (p<0.05) ns; non-significant (p>0.05)*

II. Radiographic parameters:

1- Marginal bone loss (MBL):

There was no statistically significant difference between cement retained group and screw retained group at baseline where (p=0.050).

There were a statistically significant differences between cement retained group and screw retained group at 1 month and 6 months where (p=0.002) (p<0.001) respectively. (Table 4)

Table (4) *The mean ± standard deviation (SD) and p-values of MBL in mm of both groups.*

Variables	MBL								
	Group I (Cement retained)				Group II (Screw retained)				p-value
	Mean	SD	Min	Max	Mean	SD	Min	Max	
Baseline	0.59 ^{cA}	0.07	0.25	0.95	0.39 ^{cA}	0.06	0.14	0.61	**0.050ns**
After 1m	0.92 ^{bA}	0.06	0.53	1.25	0.59 ^{bB}	0.07	0.21	0.86	**0.002***
After 6m	1.18 ^{aA}	0.03	0.95	1.31	0.79 ^{aB}	0.05	0.49	0.99	**<0.001***
p-value	**<0.001***				**<0.001***				

**; significant (p<0.05) ns; non-significant (p>0.05)*

2- Bone density (BD):

There were no statistically significant differences between cement retained group and screw retained group at baseline, 1 month and 6 months where *(p=0.879), (p=0.756)*, and *(p=0.469)* respectively. (Table 5)

Table (5) *The mean ± standard deviation (SD) and p-values of BD in HU of both groups.*

Variables	BD								
	Group I (Cement retained)				Group II (Screw retained)				p-value
	Mean	SD	Min	Max	Mean	SD	Min	Max	
Baseline	500.60 ^{abA}	123.41	378.00	668.00	509.10 ^{cA}	122.49	379.00	689.00	**0.879ns**
After 1m	518.50 ^{bA}	126.99	396.00	688.00	535.80 ^{bA}	117.77	412.00	721.00	**0.756ns**
After 6m	525.10 ^{aA}	124.73	401.00	689.00	564.80 ^{aA}	114.80	438.00	759.00	**0.469ns**
p-value	**0.001***				**<0.001***				

**; significant (p<0.05) ns; non-significant (p>0.05)*

III. Biochemical analysis:

Interlukien-1β:

There were no statistically significant differences between cement retained group and screw retained group at baseline and 3 months where *(p=0.182)* and *(p=0.201)* respectively.

There was a statistically significant difference between cement retained group and screw retained group at 1 month where *(p<0.001)*. (Table 6)

Table (6) *The mean ± standard deviation (SD) and p-values of Interlukien-1β in pg/ml of both groups.*

Variables	Interlukien-1β								p-value
	Group I (Cement retained)				Group II (Screw retained)				
	Mean	SD	Min	Max	Mean	SD	Min	Max	
Baseline	6.50 ^{bA}	0.46	5.80	7.00	6.28 ^{bA}	0.20	6.00	6.60	**0.182ns**
After 1m	6.26 ^{cA}	0.37	5.90	6.80	5.39 ^{cB}	0.29	5.00	5.80	**<0.001***
After 3m	13.41 ^{aA}	0.22	13.00	13.80	13.28 ^{aA}	0.21	13.00	13.60	**0.201ns**
p-value	**<0.001***				**<0.001***				

Means with different small letters in the same column indicates significant difference, means with different capital letters in the same row indicates significant difference

**; significant (p<0.05) ns; non-significant (p>0.05)*

Matrix metalloproteinase – 9:

There was no statistically significant difference between cement retained group and screw retained group at baseline where *(p=0.051)*.

There were a statistically significant differences between cement retained group and screw retained group at 1 month and 3 months where *(p=0.038)* and *(p=0.042)* respectively. (Table 7)

Table (7) *The mean ± standard deviation (SD) and p-values of MMP-9 in pg/ml of both groups.*

Variables	MMP-9								p-value
	Group I (Cement retained)				Group II (Screw retained)				
	Mean	SD	Min	Max	Mean	SD	Min	Max	
Baseline	863.30 ^{cA}	50.54	801.00	913.00	756.50 ^{cA}	146.06	572.00	975.00	**0.051ns**
After 1m	1292.00 ^{aA}	164.40	979.00	1521.00	1140.00 ^{aB}	137.46	949.00	1325.00	**0.038***
After 3m	1025.50 ^{bA}	116.92	824.00	1201.00	913.80 ^{bB}	110.59	746.00	1127.00	**0.042***
p-value	**<0.001***				**<0.001***				

Means with different small letters in the same column indicates significant difference, means with different capital letters in the same row indicates significant difference

**; significant (p<0.05) ns; non-significant (p>0.05)*

DISCUSSION

Cemented implant restorations have been observed to be accompanied by higher biologic complication rates than screw-retained restorations. The residual cement is a risk factor for peri-implant disease, and it can cause further marginal bone loss without rational removal. Cemented restorations are also more difficult to retrieve for subsequent maintenance [7].

Screw-retained prostheses have the advantage of being easily retrievable. However, the presence of occlusal access channels compromises their esthetics, ceramic strength, and occlusion. Cement-retained prostheses are easier to fabricate, offer easier delivery in the posterior area of the mouth, and have higher potential for passive fit [8].

The results of the present study showed that modified plaque index (mPI) in all groups during the observation period recorded, minimal plaque accumulation around the marginal area of the implants and a good oral hygiene practices by the patients, without statistically significant differences between groups. This in agreement with previous observations which concluded that implant success and failure depends mostly in patient oral hygiene and controlling plaque accumulation[9] .

At the end of the evaluation period, modified bleeding index (mBI) as a clinical indicator for absence or presence of inflammation was recorded[10]. Absence of bleeding on probing had a high positive predictive value, thus serving as a predictor for stable peri-implant conditions , that agreed with findings which found that healthy sites were characterized by absence of bleeding (0%), whereas both peri-implant mucositis and peri-implantitis sites showed substantially increased BOP (67% and 91%, respectively) [11], and no significant difference between both cement retained and screw retained groups [12].

The present study showed no statistical significant difference in peri implant probing depth between both groups during the observation period. This study declared that, the mean PIPD were 2.05mm, 2.17 mm and 2.41 mm within the observation period of the study in cement retained group and 1.74 mm, 2.10 mm and 2.14 mm at baseline, 1 month and 3 months respectively in screw retained group with no statistically significant difference between the two groups at baseline, 1 month and 3 months (p=0.50), (p=0.558), (p=0.128) respectively. Successful implants usually show a probing depth of approximately 3 mm[13]. Peri-implant probing depth 3- 5 mm and bleeding on probing were considered as threshold criteria for implant-prosthesis success and might indicate a lack of initial bone and not necessarily a periimplant pathology[14, 15].

The marginal bone loss can be considered as a predictable healthy state factor of implant rehabilitation. In the current study there was a gradual increase in marginal bone loss during the observational periods in all groups. With a mean values 0.59 mm, 0.92 mm, and 1.15 mm for cement retained group while screw retained group mean values 0.39mm, 0.59mm and 0.79 at baseline, 1 month and 6 months respectively.

The current study declare that bone density around implants of both retention technique revealed no significant difference between cement retained group and screw retained group at base line, 1 month and 6 months follow up where (p=0.879) , (p=0.756) ,and (p=0.469) respectively. Using the HU the bone density in cement retained group ranging from 378.00 – 689.00 HU, and in screw retained group it ranges from 379.00 - 759.00 HU. Such result is justified as this study baseline after 4-6 months from implant placement, after complete osseointegration[16].

The results of the current study showed no significant difference between the two groups at baseline (p=0.182), while after 1 month of the prosthetic phase there was a significant increase in IL-1β level in cement retained group where (p<0.001) with a mean value of (6.26 pg/ml) (5.39pg/ml) in

cement retained versus screw retained respectively. Then after 3 months there is an increase in the mean value of IL-1β (13.41 pg/ml) (13.28 pg/ml) respectively, but with no significant difference between the two groups (p=0.201). Implants with cement-retained or screw-retained restorations demonstrate IL-1β levels within the normal range in the peri-implant sulcular fluid provided oral hygiene is stringently maintained.

The current study showed significant differences in MMP-9 level in each group at different intervals of the samples when compared to baseline. There is significant difference between cement retained group and screw retained group at 1 month and 3 months where (p=0.038) and (p=0.042) respectively.

CONCLUSION

Cement-retained group showed significant marginal bone loss than screw retained group during the follow-up period of the study. No significant difference in radiographic bone density or clinical parameters between cement and screw retained groups.Both IL-1β and MMP-9 showed increased expression in peri-implant crevicular fluid around cement retained more than screw retained prosthesis.

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دراسة مقارنة بين الأطراف الصناعية المزروعة بالأسمنت والمسمار المحتجز من الناحية الشعاعية والسريرية والكيميائية الحيوية لمستويات IL-1β وMMP-9 في PICF

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الملخص :

الهدف: كان الهدف من هذه الدراسة هو المقارنة بين الأطراف الصناعية المصنوعة من الأسمنت والمسمار المحتفظ به في زراعة الأسنان.

المواد والاساليب: تم تقسيم أحد عشر مريضاً لديهم 22 سناً مفقوداً بشكل عشوائي إلى مجموعتين. المجموعة (11 (I موقعًا بها سن واحد مفقود تم زرعها ثم احتفظت ببدلة أسمنتية. المجموعة (11 (II موقعًا بها سن واحد مفقود تم زرعها ثم تم الاحتفاظ بطرف اصطناعي لولبي. تم أخذ المعلمات السريرية والكيميائية الحيوية عند خط الأساس 1 و3 أشهر بينما تم أخذ المعلمات الشعاعية عند خط الأساس، 1 و6 أشهر.

النتائج: أظهرت كلا المجموعتين فرقا غير كبير في MPI، MBI، PIPD وBD. أظهرت مجموعة الأسمنت المحتجزة فقدانًا عظميًا أعلى من المسمار المحتجز (P<0.001) (P=0.002) على التوالي. أظهر IL-1B وMMP-9 تعبيرًا متزايدًا في السائل الشوكي المحيط بالزرعة حول الأسمنت المحتفظ به أكثر من الطرف الاصطناعي المثبت بالمسمار.

الخلاصة: الغرسة الاصطناعية المثبتة بالبراغي تعطي نتيجة أفضل من الناحية البيولوجية من الغرسة الاصطناعية المثبتة بالأسمنت.

الكلمات المفتاحية: الأسمنت المحتجز، المسمار المحتجز، MMP-9، IL-1B، زراعة الأسنان