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Clinical and Radiographic Comparison Between Mandibular Implant Surveyed Crowns Retained Removable Partial Denture Versus Mandibular Implant Retained Overdenture

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Abstract **Aim:** To evaluate the implant surveyed crowns performance as abutments retaining removable partial denture (IC-RPDs) in comparison with implant overdentures (IODs). **Materials and Methods:** 12 totally edentulous male individuals allocated in 2 categories; Group I (n=6): planned to receive (IC-RPDs) and Group II (n=6): received (IODs). For both groups, routine surgical and prosthodontics steps for implant placement were followed. Clinical evaluations included implant survival rates(SR), percussion(P), probing depth(PD), plaque index (PI) in addition to the VAS satisfaction of function and esthetics of the two treatment modalities. Radiographic evaluations expressed differences in marginal bone heights (MBH). Evaluations are performed at insertion time of final prostheses, and after 3,6,9,and 12 months. Results were analyzed using Nonparametric ANOVA . Two-way ANOVA was used to compare Group I &II. **Results:** No statistically significant differences were founded between IC-RPDs and IODs regarding survival rates (SR) in spite that the IC-RPD group achieved 100% , and IODs group showed 83.3%. high percussion sounds were perceived during all follow-up intervals reflecting successful osseointegration. Similarly, non-significant differences were observed at all follow-up intervals between the two groups regarding Probing Depth, Plaque Index, and Marginal Bone Heights. Esthetic and functional outcomes were considerably enhanced following IC-RPDs or IODs treatments. clasp loosening, and attachment dislodgement were the apparent mechanical problems with IC-RPDs and IODs groups respectively. **Conclusion:** Under the limitations, placing implants in the front mandibular area to serve either as abutments retaining class I Kennedy Removable Partial Denture or Implant Overdentures might represent efficient treatment modalities , particularly for anatomical or economic conditions that limit placing of more numbers of implants in more posterior locations.

Keywords: *IC-RPDs, IODs, Marginal Bone Loss, Implant Complications*

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1. Introduction

As a result of decreased mandibular alveolar ridge and deficit soft tissues, Lack of retention, stability and discomfort are considered the main complaints of mandibular complete dentures. Implants were advanced to overcome retentive and supportive problems of complete dentures. Implant-supported overdentures provide a more stable and retentive solution compared to traditional removable dentures. While fixed prostheses are an option for full-arch rehabilitation, they typically require six to nine implants for support. The assignment of enough implant numbers for fixed-fixed restorations involves extensive surgeries and can be associated with high costs [1]. Patients with anatomical and socio-economic limitations may opt for implant overlay overdentures (IODs) as a routine treatment modality. This choice helps avoid additional surgeries and reduces costs compared to full fixed restorations. Implant overlay overdentures (IODs) are divided according to the attachment types into; splinted e.g., bar and clips, and non-splinted e.g., ball &sockets, locators, and magnets. These attachments provide mechanical retention for the prostheses [2]. Understanding these attachment types is crucial for clinicians when planning and designing implant overlay overdentures. The choice between splinted and solitary

attachments may depend on several factors as the personal needs, anatomical landmarks, and treatment goals. IODs are considered one of the most efficient alternative modalities for completely edentulous mandibles [3]. IODs offer several advantages over CDs; Implant-supported overdentures enhance the ability to chew food more effectively. The presence of implants improves the stability and retention of the overdenture. Overall, patients experience better oral function in IODs in comparison with traditional CDs. It aligns with the idea that implant-supported solutions provide more stable and functional alternatives for edentulous patients compared to removable complete dentures [4]. Mandibular IODs transmit less horizontal stress than that of natural teeth or implant-assisted fixed restorations. It is crucial that the attachments used in IODs provide ideal distribution of occlusal load decreasing conducted forces to the fixture and surrounding bone [5-7]. The implant design considerably affects stresses and strains transmitted to the implant. The decision to use splinted or non- splinted abutments in the context of IODs can impact stress distribution [6,8]. This implies that individual implants, rather than splinted ones, may be suitable for IODs to reduce stress and optimize implant support [9-11]. The importance of individualizing treatment plans based on the patient's anatomical characteristics and overall oral health was underscored. It aligns with the idea that a holistic consideration of factors beyond the attachment system is essential for achieving successful outcomes in implant-supported prosthetic treatments. Bone quality, quantity, implant location and arch morphology are more important than the attachment type in determining success rates of implants .The implants placing in the anterior region of the mandible may offer advantages regarding force distribution and preventing dislodgment of RPDs under vertical and horizontal forces [12-14].

IC-RPDs offer a customized solution that considers both anatomical limitations and patient preferences, ultimately providing a prosthetic option that combines the benefits of implant-supported crowns with a removable partial denture. Implant Surveyed crowns may be fabricated to serve as removable partial dentures abutments. The design of the IC-RPD involved placing two to four fixtures at the mandibular front area combined with removable prostheses [15].

Implant-related treatment plans may be affected by the success rates of implantation and amount of alveolar ridge height surrounding implants. Typically, fixed implants success percentage ranged from 92 % to 95% [16,17]while was 93% for implants in IC-RPDs[18] and 100% in implant overdentures. The survival rates of implants in previous studies had been reported as 92-100% regardless of the treatment modality [19].

Implant fixed-fixed restorations showed first-year ridge resorption surrounding implants is about (0.05 ± 0.67-1.37 ± 0.5 mm) while mandibular RPD displayed 0.13 ± 0.35 mm to 1.03 ± 0.65 mm [20]. There is a need to understand the MBL specific to IC-RPDs due to their unique combination of fixed and removable elements. Mandibular IC-RPDs are less common than mandibular implant overdentures (IODs), so there is no long-standing information about the SR and MBL around implants in IC-RPDs [21,22].

Percussion, Pocket depth, and Gingival index might be considered as index of successful treatment modality [23-26].

There were variable conclusions on patient-reported outcome measures (PROMs) when comparing IODs and fixed-fixed implant restorations. Despite heterogeneity, patients' satisfactions were increased following all kinds of implant restorations [27]. IODs can specify excellent findings related to function, esthetic, and effective retention. Given the significance of patient satisfaction, the need to check PROMs when evaluating new treatment modalities for edentulism has been pointed out.

Regarding prosthetic complications, dislodgements of the retentive elements were the most common problem in IODs [28]. There is insufficient data concerned with IC-RPDs.

The current research aimed to afford a comprehensive assessment of the performance of mandibular IC-RPDs in comparison with conventionally considered mandibular IODs.

(a)

(b)

Figure 1. (a): Clinical aspect of the lower alveolar ridge; (b): Preoperative radiographs

2. Materials and Methods

Twelve totally edentulous male individuals ; ranging from 45- 68years old , allocated in two categories: Group I(n=6): planned to receive implant surveyed crown retained RPD (IC-RPDs and Group II: received implant overlay complete dentures (IODs). The current research performed in harmony with the Helsinki Declaration and permitted from Taif University scientific research Ethics Committee. Inclusion criteria included at least one-year completely edentulous maxilla and mandible, mandibular residual alveolar ridge of adequate bone Figure 1(a) to receive 2-4 fixtures in the anterior mandibular region, and normal maxillomandibular relationships. Any condition that might influence bony or soft tissue health's,

Temporomandibular joint disorder, parafunctional problems, such as bruxism Smoking, radiation therapy history, and patients suffering from psychiatric, or physical problems were excluded from participating in this study. Regular dental and medical examinations were completed for all patients. Pre-operative radiographs Figure1(b) of implant locations were done via Cone Beam Computed Tomography (CBCT).

For both groups, routine surgical and prosthodontics steps for implant placement were followed. Alginate [1] primary impressions were taken for the maxillary and mandibular ridges and casted in stone [2] to get the diagnostic models. The study stone models were mounted on semi-adjustable articulators after recording jaw relation. The relation between the upper and lower ridges was studied from all aspects, to detect the presence of adequate interarch space for the implant abutments and attachments placement. (Figure 2)

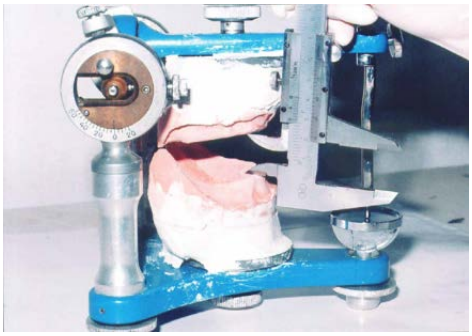

Figure 2. study casts mounted on articulator

Figure 3. surgical stent in place

Figure 4. drills were used to detect drilling position throughout the stent hole

Prospective implant sites were marked on the stone cast at the canine or premolar areas and clear surgical stents were fabricated using clear acrylic resin[3]. Patients were instructed to use mouth wash (chlorohexidine hydrochloride "Hexitol") one day before the day of surgery and for 3 minutes prior to surgery. The surgical procedures were done in two stages on the dental chair, under local anesthesia and strict measures of sterilization. The stent was placed Figure .3 to determine the area to be included in the flap. Mesiodistal incisions were made along the lingual side of the alveolar crest (3-5 mm to the crest), using blade # 15, through the attached gingiva and the mucoperiosteum. Two vertical incisions were done and extended to the depth of the buccal sulcus and the mucoperiosteal flaps were reflected. low speed, high torque and internally irrigated hand pieces were used to prepare the implant beds. Sterile saline was used for internal and external irrigation while preparing the implant beds. The stent was seated on the alveolar ridge and the drills were used to detect drilling position throughout the stent Figure 4. Stents were then removed, and the drills were used to penetrate the alveolar crest and establish the proper implant place and angle. The fixture beds were enlarged with drills of 2 mm,3.5 mm, and 4 mm diameter successively to proper depth marked on the drill (11 mm). Profuse irrigation and frequent cleaning of the drills were performed. The drilling motion was always done in an upwards and downward direction to avoid over-sizing of the fixture bed and to allow irrigation solution to reach the full hole depth. The endosseous screw type implant [4] mounted on the vial cap was inserted in place, and wrench systems were applied to complete seating of the implant in place. Figure 5&6

Flat cover screws in the silicone stoppers were removed and threaded to the implant fixture with the 0.9 mm hex screwdriver, making sure that the cover screw is in intimate contact with the fixture to prevent the growth of bone inside the fixture. The mucoperiosteal flap was repositioned and sutured over the empty hole using # 4-0 braided absorbable sutures 5 Figure 7. Antibiotics, analgesics, and chlorhexidine mouth wash were recommended for 5 days. Post-operation problems, as well as the extent of any oedema or hematoma were checked the day after the operation . The operation site was also checked for any flap defect or cut sutures.

After four months of implant placement the patients were examined clinically to ensure complete healing and periapical radiographs were done for each side to evaluate osseointegration Figure 8 The area surrounding the implants was locally anesthetized by infiltration technique. The patients were asked to use Chlorohexidine mouth washes. The fixtures were located by probing guided with the patient's surgical stent. small crestal incisions above cover screws were made to display fixtures. The titanium covering screws were removed. Suitable heal abutments were placed and screwed carefully to the implant fixture

1 Kromalgin,Vannini Dental Industry, Italy.

2 Durguix, Protechno, Girona, Spain

3 Eco-cryl cold. Protechno, Girona, Spain.

4 ENDURE, IMTEC Co. Ardmore, Oklahoma 73401, U.S.A.

5 Vicryl, W 9106, Johnson & Johnson.

by hex driver so that the tip of the healing abutment did not exceed 2mm above the gum Figure 9. Excess tissues around the healing abutments were excised and the incision was tightly sutured. The patients were instructed to rinse with Hexitol mouth wash three times daily and to use soft toothbrush to keep the healing abutments clean. The healing abutments were left for two weeks for gingival collar formation.

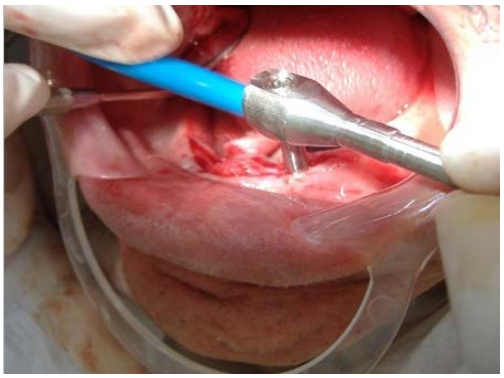

Figure 5. Implant placement by the ratchet wrench

Figure 6. Implants placed in the prepared osteotomies before suturing

Figure 7. sutures after surger

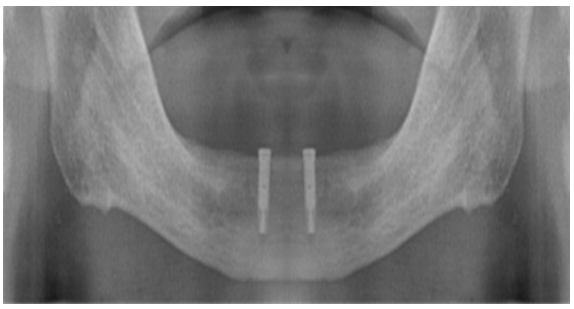

Figure 8. Radiographs prior to second stage surgery to evaluate Osseo integration

Figure 9. The healing abutments in place

For both groups, prosthodontic techniques were accomplished. Alginate mandibular impressions were made for the lower jaw with the heal abutments in position, also maxillary primary impressions were recorded. The surface area around and above the healing abutments was enlarged with wax to stimulate the position of impression copings that will be used and perforated acrylic individual trays were fabricated. The maxillary secondary impressions were also recorded with light body additional silicone impression materials Figure 10. For making the mandibular impressions, after removal of healing abutments, the impression transfer copings were tightened into the fixtures. The trays were checked, impression copings were visible through the window Figure 11. Final mandibular impressions were recorded by rubber base impression material6 While still seated in the mouth, the transfer copings were loosened from fixtures, then impressions were removed with transfer copings Figure 12. The implant analogues were screwed with impression transfer copings, extra care was taken not to change the position of the copings in the impression material during manipulation, then the assembly were casted. After stone setting, the impressions were removed Figure 13. For group I: Occlusal rims were manufactured using self-curing resin and base plate wax, and the intermaxillary relationships were recorded. Facebow transfers were performed and mounted on semi-adjustable articulators. The implant abutments were manufactured by milling a comment-retaining abutment. In the IC-RPDs, all implants were in the cuspid or premolar areas therefore, become as Class I modification 1 Kennedy classification. Mandibular partial denture designing principles were followed including lingual plates to maximize the stability of the dentures, and the clasps were designed to decrease lateral force applied to the implant abutment. Cingulum rest seats were designed for the right and left canine teeth in cases of two implants and in cases of four implants, occlusal rests for the first and second premolars. The occlusal surfaces of the premolars were made of a metal occlusal surface to prevent wear of the opposing complete denture resin teeth. After confirming the suitability of the metal coping of the Surveyed Crowns, the ceramic materials

6 Variotime®Light Flow Refill, Kulzer GmbH, Leipziger Straße 263450 Hanau, Germany.

were layered to complete the final surveyed crowns. After intraoral try-in of the completed abutments and surveyed crowns, the upper complete dentures and lower partial dentures manufactured according to conventional methods. Implant Surveyed Crowns were cemented using temporary implant cement. Bilateral balanced occlusions were provided to stabilize the denture during lateral movement Figure 12. After wearing the dentures, assessments were accomplished at insertion time of final prosthesis, and after 3,6,9,and 12 months.

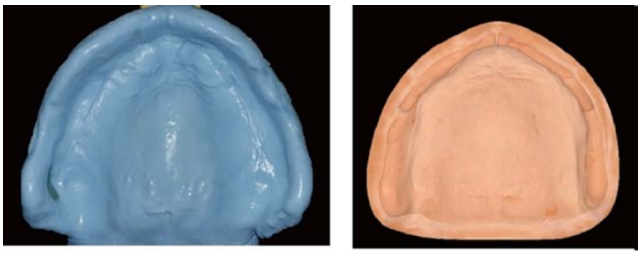

Figure 10. Maxillary secondary impression and model

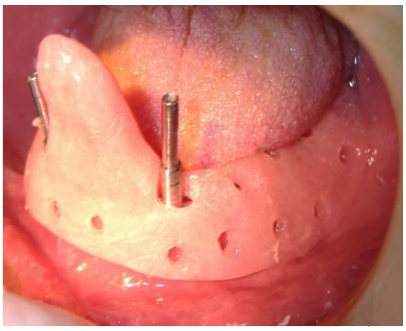

Figure 11. Checking of special acrylic tray and impression copings

Figure 12. Implant analogues connected to impression copings

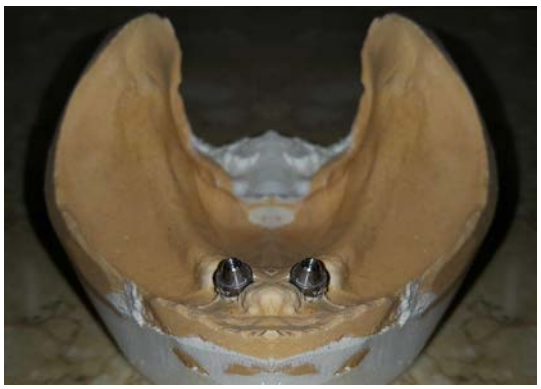

Figure 13. Mandibular master cast

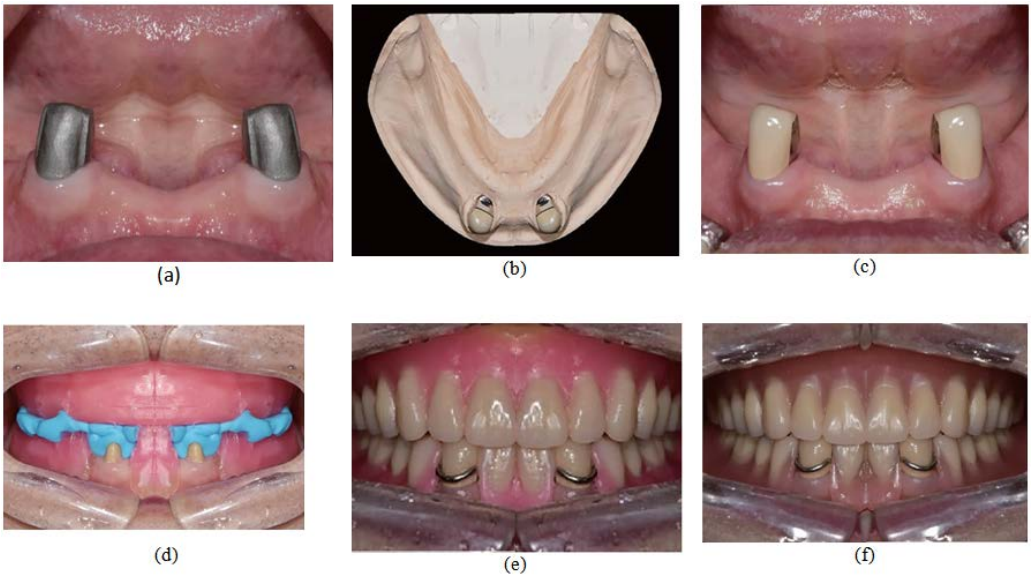

Figure 14. consequent steps to fabricate IC-RPD; (a) Surveyed Crowns Metal coping Try-in, (b) ceramic materials layered to complete the surveyed crowns, (c)Implant Surveyed Crowns cemented using temporary implant cement, (d) Jaw Relation, Try-in of the final prosthesis, and (f) insertion of IC-RPD

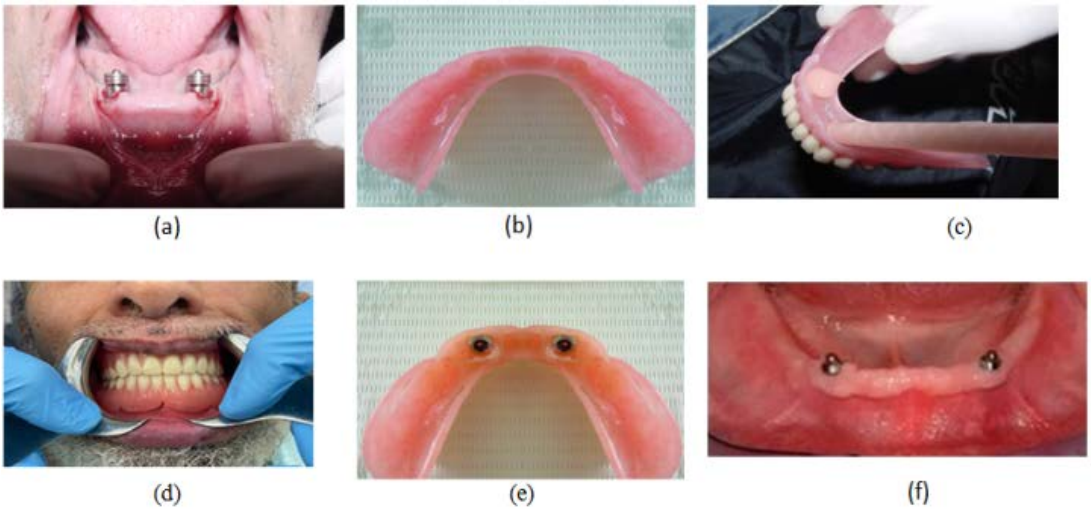

Figure 15. consequent steps to fabricate IOD. (a) attachment components located on the ball abutments, (b) relief areas in fitting surface of lower denture, (c) application acrylic resin by gun, (d)Patient asked to occlude to pick-up the metal keeper and O-rings, (e) metal keepers and O-rings attached to the tissue surface of mandibular denture, and (f) clinical aspect of the ball abutment in place

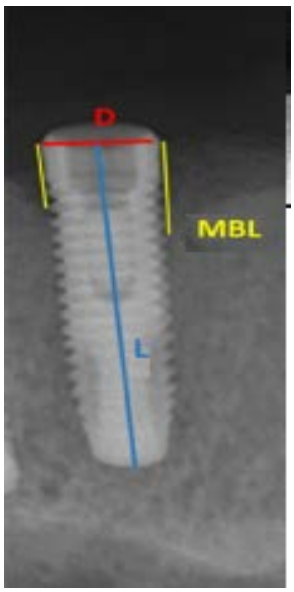

Figure 16. Marginal bone changes in height D:iameter, L:Length, and MBL:marginal bone loss

For group II: Bite registrations were made, teeth were selected, and waxed denture was constructed. The working cast and the opposing model were mounted on an articulator. The try-in denture was verified, and necessary adjustments were made. After removal of Healing abutments, the O-ball abutments[7] were secured in position and tightened with torque wrench to 32N with O-ball abutment seating tools onto the implants. O-rings and keepers were secured in position. The fitting surfaces of mandibular prostheses were relieved in the areas opposing to prosthetic components until the denture could be seated in place passively. Pick-up techniques were utilized to connect the O-ring system in place. Adhesives were painted first by the aid of a brush in the relieved areas and cold-cured, self-cured acrylic resins were applied by using a gun. The dentures were seated in place over the O-ball system and left undisturbed in the close-mouth position until complete setting and hardness of the material. The dentures were removed and checked for the proper attachment of the O-ring and keeper to its fitting surface. The dentures were finished then checked for the accurate fitting of the attachment components. Dentures were delivered to the patient after careful evaluation of occlusion and patients were instructed for the proper way of denture using.

Evaluations: Assessments were accomplished at insertion time of final prosthesis, after 3,6,9,and 12 months regarding the following parameters:

Implant survival rate: Implants are judged as successfully survive if the implant and final restoration have normal function at the last checkup period [29].

Percussion (P)*:** The sounds recorded with percussion on the implant abutments were considered as index of successful treatment as follow; ***Score 0: high sound specifying intimate connection of implant and bone (osseointegration) , ***Score1:*** dull sound , reflecting implant mobility [23].

***Probing Depth (PD)*:** Graduated periodontal probes were used to measure the depths of the gingival sulcus around the implant abutments. The probes were inserted between the oral sulcular epithelium and the abutment with minimal pressure and measure the distances from gingival sulcus bottom to free gingival margin in the middle of all implant surfaces (B,L,M and D). Abutment pocket depth is the average of the four evaluations. The probing depth of each patient was the average depth of left and right implants.[24]

Plaque Index (PI): Mombelli indexes were utilized to measure the plaque retained on the implant supra-mucosal part [26] . ***Score 0:*** Negative, ***score 1:*** detection by probes, ***score 2:*** detection by naked eye, and ***Score 3:*** Great quantity.

Marginal bone Height (MBH)

Distances from alveolar crests to the implant's apexes were assessed along distal and mesial surfaces of each implant. Distal and mesial alveolar bone height are the mean of two distal and two mesial measures of the two implants respectively. The bone heights were detected in

7 O-ring system, IMTEC Co. Ardmore, Oklahoma 73401, U.S.A.

the same manner for each implant. Marginal Bone Loss is defined as variations in mean values of marginal bone heights on mesial and distal surfaces of implant between last and first follow-up measurements [30].

Patient-reported outcome measures (PROMs): QOL in addition to patient satisfaction considered the most important factors determining the choice of any rehabilitation methods [31]. Patients were surveyed the Patient-reported outcome measures following IC-RPDs or IODs modalities using visual analog scales (VAS) ranging from one to five, (one was the least favorable response and five is the highest response). The surveys requested the individuals to evaluate functional and appearance satisfaction before and after receiving final prosthesis.

Prosthetic complications

Reviewing the patients' files, different clinical or laboratory complications related to both treatment modalities can be detected and identified. Prosthodontic complications may be categorized into five groups; (a) fracture or distortions of any component of the denture that required repairing or necessitated construction of new prosthesis. (b) loosening or fractures of the implant screw. (c) surveyed crown dislodgement or fracture of the porcelain veneer in in PFM surveyed crowns in IC-RPD group. (d) loss, movement, or dislodgement of the O-ring attachments. (e) sore spots or ridge resorption in IODs group.

Statistical Analysis

Results were analyzed using Nonparametric ANOVA . Two-way ANOVA was used to compare Group I &II.

Implant survival rate: Throughout the follow-up intervals, two implants of total sixteen weren't successfully survived; so, the total percentage of survived implants was 87.5%. Comparing the study groups, no implant failed in IC-RPDs and 2 failed IODs with final survival rates of 100 % and 83.3 % for both groups respectively. The variances were not significant ($P > 0.05$). One of the two failed implants were still survived till 5 months while the other one failed after eleven months.

Percussion (P): At all intervals of the follow-up periods, Percussion on all implants in group I showed high sound (score 0) representing intimate connection of implants to bone i.e., successful osseointegration. while two implants in IODs groups showed dull sound (score 1) at the fifth, and eleven months follow up with peri-implantitis.

Probing depth(PD): IC-RPDs and IODs Probing depth mean values and standard deviations throughout the follow up periods were summarized in tables (1), and figure (17). Statistical analysis of PD mean values showed no significant difference between insertion time and 3 m, between 3 and 6 m, between 6 and 9 m, and between 9 and 12 months. Significant differences were detected between insertion time and 6 m, in between 3 and 9 m, and in between 6 and 12 m. extremely significant variations in between insertion time and nine and 12months, and between three- and twelve-months Table 2. Comparison of the probing depth mean values for the IC-RPDs group against IODs group displayed non-significant differences throughout all the follow-up periods Table 3 and Figure 18.

3. Results

Table 1. probing depth(mm) for both groups

	IC-RRPD					IOD				
Parameter	Insertion	3m.	6m.	9m.	12m.	Insertion	3m.	6m.	9m.	12m.
Minimum	0.71	0.78	0.84	0.87	0.92	0.675	0.75	0.81	0.85	0.9
Maximum	0.75	0.84	0.89	0.92	1	0.75	0.86	0.92	0.95	1.2
Mean	0.73	0.8125	0.866	0.897	0.953	0.717	0.806	0.8742	0.9041	1.006
Std. Deviation	0.01269	0.01783	0.01578	0.01494	0.02751	0.02486	0.03134	0.03046	0.02827	0.1053
Std. Error	0.00401	0.00564	0.00499	0.00473	0.0087	0.00786	0.00991	0.00963	0.00894	0.03331

Table 2. Dunn's Multiple Comparison Test within IC-RPD and IOD groups regarding to probing depth

	IC-RPD			***IOD***		
Multiple Comparison	Differences	P- value	Sig.	Differences	P -value	Sig
IN X 3M	-10.05	P > 0.05	NS	-8.5	P > 0.05	NS
IN X 6M	-20.7	P < 0.05	*	-21.25	P > 0.05	NS
IN X 9M	-29.35	P < 0.001	***	-45.71	P < 0.001	***
IN X 12M	-39.9	P < 0.001	***	-48.29	P < 0.001	***
3M X 6M	-10.65	P > 0.05	NS	-12.75	P > 0.05	NS
3M X 9M	-19.2	P < 0.05	*	-37.21	P < 0.01	**
3M X 12M	-29.85	P < 0.001	***	-39.79	P < 0.001	***
6M X 9M	-8.65	P > 0.05	NS	-24.46	P > 0.05	NS
6M X 12M	-19.2	P < 0.05	*	-27.04	P > 0.05	NS
9M X 12M	-10.55	P > 0.05	NS	-2.575	P > 0.05	NS

IN: time of insertion, NS: no significant difference, *: significance, **: highly significance., ***: extremely significance. X:versus

Table 3. Dunn's Multiple Comparison Test between IC-RPD and IOD groups regarding probing depth.

Multiple Comparison	Rank sum differences	P - value	Sig.
IN_C X In_O	3.25	P > 0.05	NS
$3M_C$ X $3M_O$	1.9	P > 0.05	NS
$6M_C$ X $6M_O$	-5.55	P > 0.05	NS
$9M_C$ X $9M_O$	-3.15	P > 0.05	NS
$12M_C$ X $12M_O$	-1.05	P > 0.05	NS

INC: time of insertion of IC-RPD group, INO: time of insertion of IOD group, 3MC: three months of IC-RPD group, 3MO: three months of IOD group, 6MC: six months of IC-RPD group, 6MO: six months of IOD group, 9MC: nine months of IC-RPD group, 9MO: nine months of IOD group, 12MC: twelve months of IC-RPD group, and 12MO: twelve months of IOD group

***plaque* index:** The IC-RPDs and IODs plaque index mean values and standard deviations throughout follow up period were summarized in Tables 4, and Figure 19. Statistical analysis showed no significant differences between time of insertion and 3m., in between time of insertion and 6m., in between 3 and 6 m., in between 3 and 9m. , in between 6 and 9 m., and in between 9 and 12m. There were significant variances among 6 and 12 months, highly significant differences between 3and 12 months and very highly significant difference among time of insertion and 9m., and in between time of insertion and 12m. Tables 5. Comparing the gingival index mean values of the IC-RPD versus IODs groups displayed non-significant differences at different follow-up intervals Table 6 and Figure 20.

Table 4. Descriptive statistics of plaque index for both groups

	IC-RPD					IOD				
Parameter	Insertion	3m.	6m.	9m.	12m.	Insertion	3m.	6m.	9m.	12m.
Minimum	0	0	0	0	0	0	0	0	0	0
Maximum	1	1	1	1	2	1	1	2	2	2
Mean	0.225	0.425	0.5	0.75	0.9	0.25	0.425	0.625	0.925	1.075
Std. Deviation	0.4229	0.5006	0.5064	0.4385	0.6325	0.4385	0.5006	0.6279	0.6938	0.8286
Std. Error	0.06687	0.07916	0.08006	0.06934	0.1	0.06934	0.07916	0.09928	0.1097	0.131

Table 5. Dunn's Multiple Comparison Test within IC-RPD& IOD groups regarding plaque index

	IC-RPD			IOD		
Multiple Comparison	Difference	P-value	Sig.	Difference	P- value	Sig.
IN X 3M	-19.4	P > 0.05	NS	-15.23	P > 0.05	NS
IN X 6M	-26.68	P > 0.05	NS	-30.08	P > 0.05	NS
IN X 9M	-50.93	P < 0.001	***	-51.93	P < 0.001	***
IN X 12M	-58.88	P < 0.001	***	-59.03	P < 0.001	***
3M X 6M	-7.275	P > 0.05	NS	-14.85	P > 0.05	NS
3M X 9M	-31.53	P > 0.05	NS	-36.7	P < 0.05	*
3M X 12M	-39.48	P < 0.01	**	-43.8	P < 0.01	**
6M X 9M	-24.25	P > 0.05	NS	-21.85	P > 0.05	NS
6M X 12M	-32.2	P < 0.05	*	-28.95	P > 0.05	NS
9M X 12M	-7.95	P > 0.05	NS	-7.1	P > 0.05	NS

Table 6. plaque index Comparison between IC-RPD and IOD groups

Multiple Comparison	Rank sum Difference	P-value	Sig.
IN_C X In_O	-4.6	P > 0.05	NS
$3M_C$ X $3M_O$	0	P > 0.05	NS
$6M_C$ X $6M_O$	-17.15	P > 0.05	NS
$9M_C$ X $9M_O$	-16.6	P > 0.05	NS
$12M_C$ X $12M_O$	-14.65	P > 0.05	NS

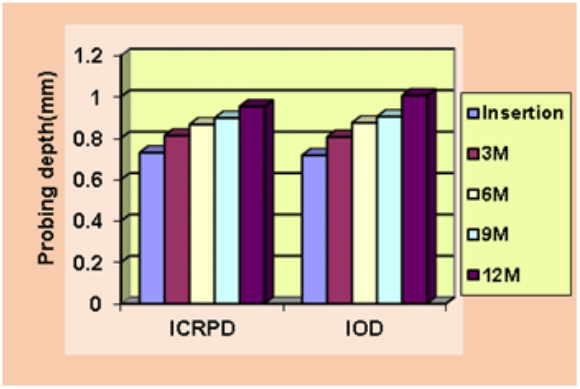

Figure 17. Histogram of probing depth mean values

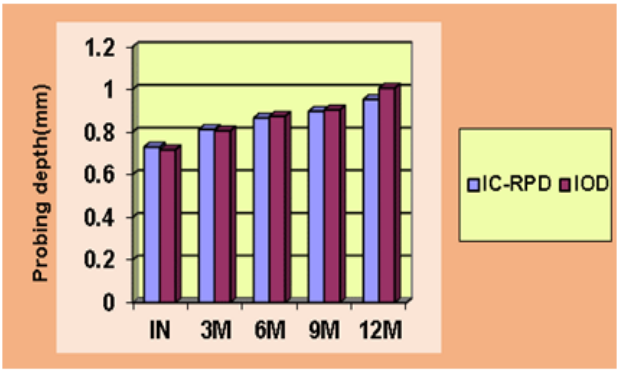

Figure 18. A column chart of probing depth mean values for *IC-RPD vs IOD groups*

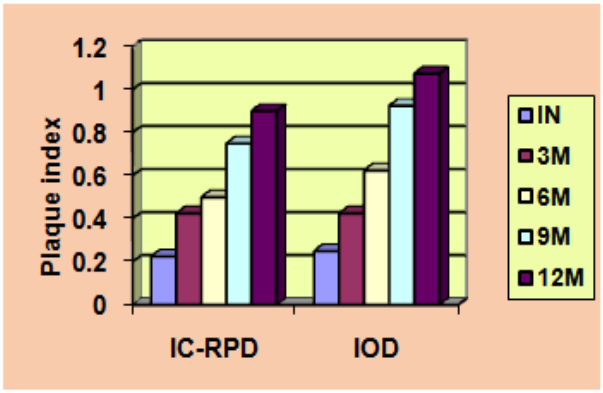

Figure 19. Histogram of plaque index mean values

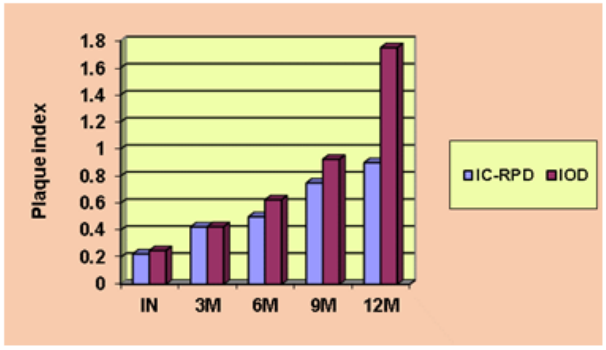

Figure 20. IC-RPD vs IOD groups plaque index mean values

Marginal bone height and Marginal bone loss:

The IC-RPDs and IODs bone height mean values and standard deviations throughout follow up period were summarized in Table.7, and Figure 21. Analysis of the IC-RPDs and IODs results showed no significant differences between insertion time and 3m, in between 3 and 6m.., in between 6 and 9m., and in between 9 and 12m. While significant differences were recognized between the insertion time and six months, between three and nine months and between six and twelve months . There were very highly significant differences between the insertion time and nine months, between time of insertion and twelve months and between three and twelve months (Table 8) . Comparing the bone height mean values for I-C RPDs and IODs groups displayed non-significant differences at the different follow-up intervals Table 9 and Figure 22.

Patient-reported outcome measures (PROMs) at insertion, after 3,6,9, and 12 recall checks:

the patients' satisfactions regarding function, and esthetics in IC-RPDs and IODs groups, were considerably enhanced ($p < 0.001$) following receiving final prostheses Figure 23. Patients in IC-RPDs expressed higher responses for masticatory function and lower responses for esthetics than IODs patients.

Table 7. mean values of bone height(BH) for IC-RPDs and IODs groups

	IC-RPD					IOD				
Parameter	Insertion	3m.	6m.	9m.	12m.	Insertion	3m.	6m.	9m.	12m.
Minimum	12.1	11.7	11.5	11	10.8	11.9	11.6	11.4	11	10.5
Maximum	12.3	12.1	11.9	11.6	11.2	12.3	12	11.8	11.4	10.9
Mean	12.18	11.91	11.66	11.33	11.03	12.1	11.81	11.62	11.23	10.74
Std. Deviation	0.07888	0.137	0.143	0.1636	0.1418	0.1333	0.1524	0.1317	0.1418	0.1265
Std. Error	0.02494	0.04333	0.04522	0.05175	0.04485	0.04216	0.04819	0.04163	0.04485	0.04
Lower 95% CI	12.12	11.81	11.56	11.21	10.93	12	11.7	11.53	11.13	10.65
Upper 95% CI	12.24	12.01	11.76	11.45	11.13	12.2	11.92	11.71	11.33	10.83

Table 8. Dunn's Multiple Comparison Test within IC-RPD& IOD groups regarding to mean bone height

	IC-RPD			IOD		
Multiple Comparison	Difference	P-value	Sig.	Difference	P- value	Sig.
IN X 3M	10.3	P > 0.05	NS	10.25	P > 0.05	NS
IN X 6M	19.05	P < 0.05	*	17.5	P > 0.05	NS
IN X 9M	29.8	P < 0.001	***	29.05	P < 0.001	***
IN X 12M	38.85	P < 0.001	***	39.2	P< 0.001	***
3M X 6M	8.75	P > 0.05	NS	7.25	P > 0.05	NS
3M X 9M	19.5	P < 0.05	*	18.8	P < 0.05	*
3M X 12M	28.55	P < 0.001	***	28.95	P<0.001	***
6M X 9M	10.75	P > 0.05	NS	11.55	P > 0.05	NS
6M X 12M	19.8	P < 0.05	*	21.7	P < 0.01	**
9M X 12M	9.05	P > 0.05	NS	10.15	P > 0.05	NS

Table 9. Dunn's Multiple Comparison Test between IC-RPDs and IODs groups regarding bone height mean values

Multiple Comparison	Difference in rank sum	P-value	Sig.
IN_C vs In_O	6.15	P > 0.05	NS
$3M_C$ vs $3M_O$	7.85	P > 0.05	NS
$6M_C$ vs $6M_O$	2.9	P > 0.05	NS
$9M_C$ vs $9M_O$	5.7	P > 0.05	NS
$12M_C$ vs $12M_O$	11	P > 0.05	NS

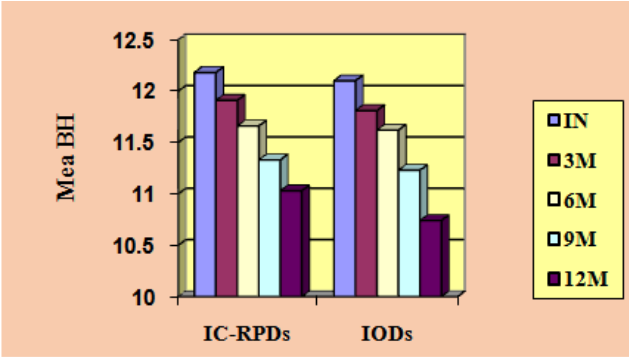

Figure 21. Histogram of bone height mean values

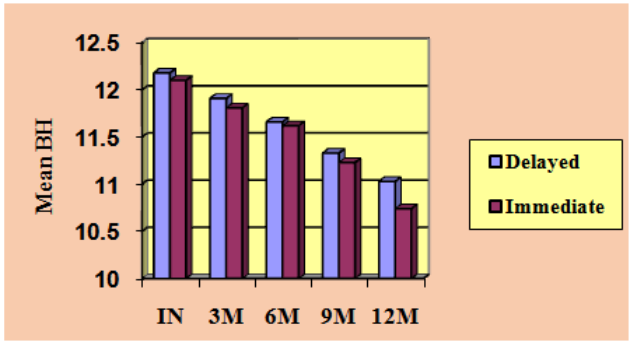

Figure 22. A column chart of mean bone height mean values for IC-RPD vs IOD groups

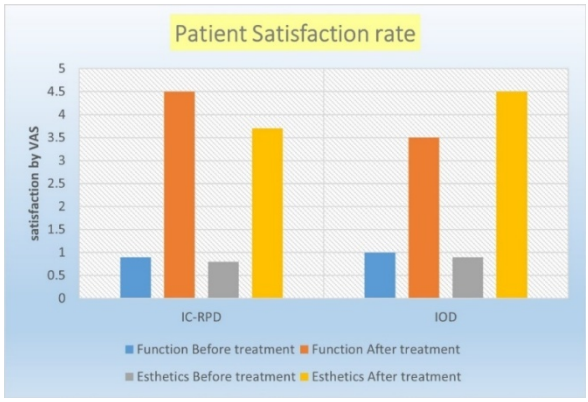

Figure 23. Patient satisfaction rate for both groups before and after treatments

Prosthodontic complications

The overall technical difficulties in this study was recognized much earlier in IC-RPDs groups prior to IODs group. These problems could be categorized under 5 classes: clasps loosening in IC-RPDs(22%), pain beneath IODs base (20%), movement or wear out of O-ring (18%), bone resorption underneath the IOD base (12%). two IODs base fractures were noted. These technical problems were solved by repairing or replacing dislodged parts.

4. Discussion

Patients may sometimes find difficulty in adaptation to conventional removable complete dentures, especially in the mandibular arch and at the same time cannot be rehabilitated with fixed prosthesis due to anatomical or socioeconomic causes. In these cases, another treatment modality can be suggested to retain and stabilize mandibular dentures including placing minimal number of fixtures in the mandibular anterior. This can help individuals to be satisfied with the new dentures, improving patient quality of life [13,31,32]

In this study pocket depth was measured by using manual graduated probe which was inserted between the abutment and sulcular epithelium under minimal pressure. Furthermore, to assess implants osseointegration, percussion was performed by tapping each implant, a solid ringing sound indicated direct bone with implant contact, while a dull sound denoted failure of osseointegration and presence of fibrous tissue [23,26].

The final outcomes of this study displayed that non-significant changes were founded in between IC-RPDs and IODs regarding survival rates (SR) in spite that the IC-RPD group achieved 100% , and IODs group showed 83.3%. SR. For lower complete dentures. IODs were recommended as successful treatment modality with high clinical outcomes [33]. IC-RPDs, despite displaying higher SR than IODs in current research , cannot be considered as an alternate option to IODs and require additional longstanding researches. IC-RPDs group showed no failed implants while IODs group displayed two failed implants. The occlusion with opposing arch is very important in expecting the success rate of implants. Both groups opposed upper complete denture so this factor may not be considered as a reason for differences in SR results of the two treatment modalities. Other factors such as age, masticatory forces, implant location, bone quality and oral hygiene may be considered [34] .

Marginal Bone heights were evaluated at insertion time , at 3,6,9, and 12 months after receiving final restorations. MBL findings of IC-RPDs did not markedly differ from IODs MBL findings and were within the normal values recorded by other studies [35-37]. This was proved by performing percussion on the implants where high sound (score 0) representing intimate connection of implants to bone i.e., successful osseointegration. IC-RPDs and IODs groups showed 0.87+0.99 and 1.92 + 1.84 mm, mean marginal loss respectively, which were acceptable with normal values of first year bone resorption following implant placement. These differences were non-significant at the end of the study. These findings were in agreement with Bae at el. [36]. IC-RPDs and IODs showed higher marginal bone loss than fixed restorations , this can be explained by harmful lateral forces produced by removable prosthesis retentive parts.

The IC-RPDs and IODs probing depth mean values throughout follow-up is slightly increased but still inside the acceptable scales. This may occur because of bone resorption around implants[23].

The plaque index measures showed statically non-significant variations among IC-RPDs and IODs. While within the same group, slight inflammatory reactions were detected after one year in both groups. The study outcomes were in harmony with other researches which clarified increased inflammatory reactions of the gingiva is due inability of the patients to maintain good oral hygiene [25,26]

Patient satisfaction and quality of life are considered essential parameters in evaluation of any method of treatment [31,38]. In current study, patients responded to

questionnaire called patient-reported outcome measures (PROM) assessing patient satisfaction related to esthetics and masticatory functions. PROM results denoted that both IC-RPDs and IODs exhibited significant enhancement of function and esthetic outcomes following prostheses delivery.

IC-RPDs group show significant improvement ($p < 0.001$) regarding functional VAS scores than IODs. This can be explained as patient feel more convenient with few fixed restorations that improve masticatory efficiency in IC-RPDs group. On the hand, regarding esthetic VAS scores, IODs patients exhibited higher responses than IC-RPDs, this can be attributed to conspicuous clasps in the front area of the mandible.

Repeated placement, and removal of IC-RPDs lead to fracture or loosening of clasps. This was the main common complications which was easily repaired. Conversely, attachments dislodgements, sore spots under dentures, and bone resorption were the utmost repeated mechanical problems in the IOD group. O-ring attachments used in IODs eroded by time and necessitated to be changed and/ or denture relining [28,33].

The implant number is very important in detection of the type of final prosthesis. Full arch rehabilitation with fixed-fixed restoration needs at least 6-9 implants whereas only 2-4 implants necessitated in IC-RPDs or IODs [20]. IOD utilizing two implants was a cost-economical treatment [39]. Two implants supported Overdenture were evaluated as an efficient treatment alternative [3,34]. Using 1–2 implants in IODs, the attachments are exposed to higher stresses and wear down [12,33] in comparison to somewhat improved results exhibited using four implants [34]. Hence, using 2-4 implants for IC-RPDs or IODs would be sufficient in cases of anatomical or economical limitations.

One additional important factor is the relation between force distribution and Implant location. The . implant assisted RPD biomechanics were improved by placing implants in the 1st. molar area, but this may be impaired by inadequate bone quantity or quality resulting in placing implants in a more anterior positions. Moving implants from last molar to premolar region markedly display better distribution of forces. Acceptable outcomes have been reported in many studies placing implants in the front area of the mandible [35,40].

5. Conclusions

Under the limitations, insertion of fixtures in the mandibular front region to serve as surveyed crowns retaining removable partial denture or as abutment for Implant overdentures might represent efficient treatment modalities , particularly for anatomical or economic conditions that limit placing of more numbers of implants in more posterior locations. No statistically significant differences were founded between IC-RPDs and IODs regarding survival rates (SR) in spite that the IC-RPD group achieved 100%, and IODs group showed 83.3%. SR. The mean MBL OF I C-RPDs and IODs groups were 0.87+0.99 and 1.92 + 1.84 mm, respectively, which were acceptable with normal values of first year bone resorption following implant placement. These differences were non-significant at the end of the study. PROM results of patient satisfaction denoted that both IC-RPDs and IODs exhibited significant enhancement of function and esthetic outcomes following prostheses delivery. Clasp loosening and attachment dislodgement were the most common mechanical problems in IC-RPDs and IODs respectively.

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